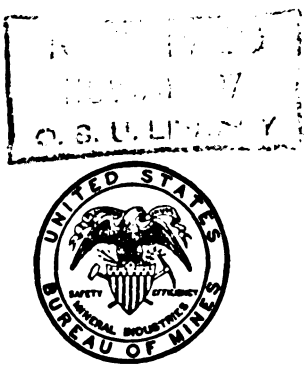
I. C. 6965 OCTOBER 1937

DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

VENTILATION AT THE ANTHRACITE COLLIERIES OF THE NORTHERN PENNSYLVANIA FIELD



BY

G. E. McELROY

AFTER THIS REPORT HAS SERVED YOUR PURPOSE AND IF YOU HAVE NO FURTHER NEED FOR IT, PLEASE RETURN IT TO THE BUREAU OF MINES, USING THE OFFICIAL MAILING LABEL ON THE INSIDE OF THE BACK COVER.

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from THE OHIO STATE UNIVERSITY

I.C. 6965
October 1937

INFORMATION CIRCULAR

DEPARTMENT OF THE INTERIOR-BUREAU OF MINES

VENTILATION AT THE ANTHRACITE COLLIERIES OF THE NORTHERN PENNSYLVANIA FIELD[1]

By G. E. McElroy[2]

INTRODUCTION

This paper[3] is one of a limited series being prepared by the Bureau of Mines to supplement a more extensive series on mining and preparation methods in the various mining districts of the United States. It describes ventilation methods and practices at the anthracite collieries in the Northern field of the anthracite measures of Pennsylvania as obtained by personal inspections in twenty of the larger collieries during 1933 and 1934 and from supplementary information furnished then and later by operating officials.

This field is one of the four major divisions - Northern, Eastern Middle, Western Middle, and Southern - into which the anthracite deposits of Pennsylvania are naturally divided, and constitutes, in plan, a slightly bowed lens, about 60 miles long, and that extends from Forest City on the north through Scranton, Pittston, Wilkes-Barre, and Nanticoke to Shickshinny on the south with a maximum width of 6 miles. It is the oldest and largest producing field of the four, and has produced continuously from 1808. The total anthracite production for the State reached a peak of about 100,000,000 tons a year in 1917, but in recent years production has averaged about 50,000,000 tons, of which somewhat over half comes from this Northern field. The operations of three of the largest producing organizations in the State are almost wholly included in this field, as well as about half of the operations of two others of the six largest producers. It comprises the first 14 of the 25 numerically designated anthracite State inspection districts.

Although a very considerable number of independent operations is also involved, the bulk of production comes from the large collieries of the main-line organizations and largely from the southern and most gassy part of the field, which grades from practically nongassy in the northern part to slightly gassy throughout the central (Scranton-Pittston) area and to very gassy from Wilkes-Barre south.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular No. 6965."

2/ Supervising engineer, Mine Ventilation Section, Mining Division, U. S. Bureau of Mines.

3/ Manuscript completed September, 1935.

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The three largest collieries produce an average of 5,000 to 6,500 tons a day with 1,600 to 1,800 employees underground on one or two shifts, and require a million or more cubic feet of ventilating air per minute each, or the equivalent of somewhat more than 9 tons of air per day per ton (2,240 pounds) of coal produced. The average large colliery produces 2,500 to 4,000 tons a day and requires four to five hundred thousand c.f.m. to ventilate it.

The latest statistics on fan performances published by the State inspection department are for 1929-30. From these and the data on separate groups for 1933-34 it is estimated that fans circulating more than 25,000,000 c.f.m. are operating continuously and that the yearly cost of ventilation is something like $3,500,000. The magnitude of the ventilation problem in this field is apparent, therefore, and represents more air mechanically handled than for all of the metal mines of the United States, Canada, and Mexico combined.

Production of methane varies from about 10 cubic feet per day per ton of average daily production for the nongassy operations to a maximum of 1,600 for a very gassy operation and to a maximum of 6,500,000 cubic feet per 24 hours for one of the largest gassy collieries.

ACKNOWLEDGMENTS

The author wishes to acknowledge the many courtesies extended to him by mining officials during his stay in the field and, particularly, assistance in the preparation of certain of the drawings that appear in this report.

MINING CONDITIONS

Coal Beds

The coal measures of the Northern field include a series of 5 to 15 roughly parallel beds of minable anthracite coal of variable thickness underlying broad valleys flanked on each side by low hills. The beds form undulating troughs, with dips roughly normal to the northeast-southwest axes of the valleys, and for the most part outcrop either close to or on the flanks of the adjoining hills. From Pittston south to Nanticoke, operations are in the Wyoming Valley, roughly 3 miles wide, through which the North Branch of the Susquehanna River flows in a general southwesterly direction, and in which there is also a "buried valley" of water-filled sand and gravel paralleling the river on the north side. North of Pittston operations are in the Lackawanna Valley, which has a maximum width of 6 miles and through which the Lackawanna River flows. South of Nanticoke the field cuts across a bend in the river and occupies low hills east of it.

Although the beds have variable dips, from flat to vertical, and are folded and faulted to a considerable degree, both the average dip and the degree of folding and faulting increase rather uniformly from north to south, as do the number of beds and their average depth also. The general tendency is for the troughs or basins to dip at low angles to the southwest parallel to

Generated on 2024-09-18 03:14 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:13 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

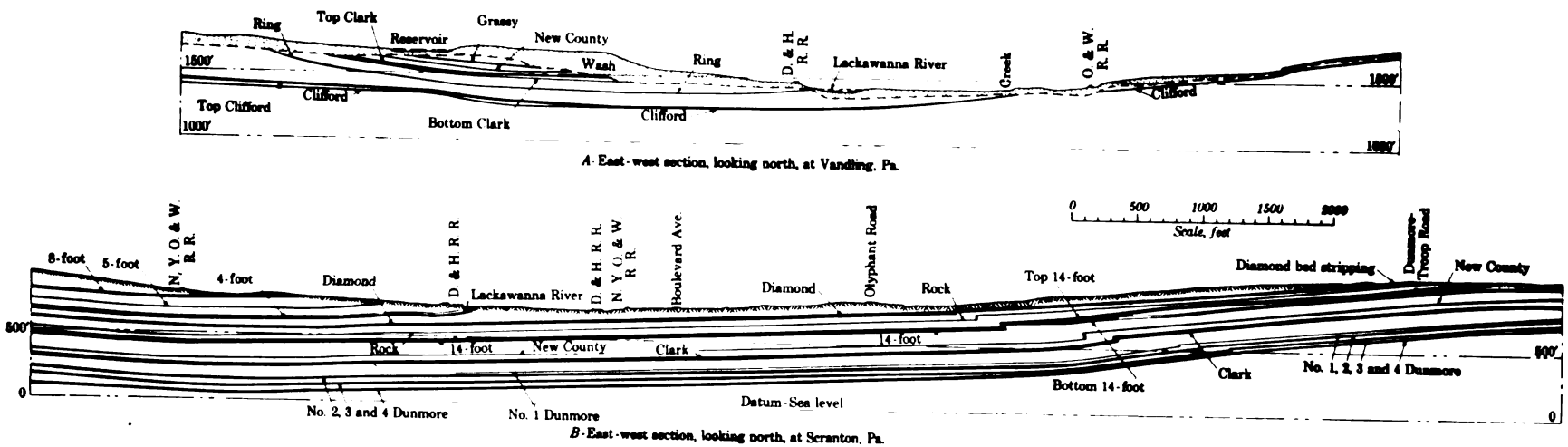


Figure 1.-Typical sections across the coal beds of the northern and central parts of the northern anthracite field.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:13 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

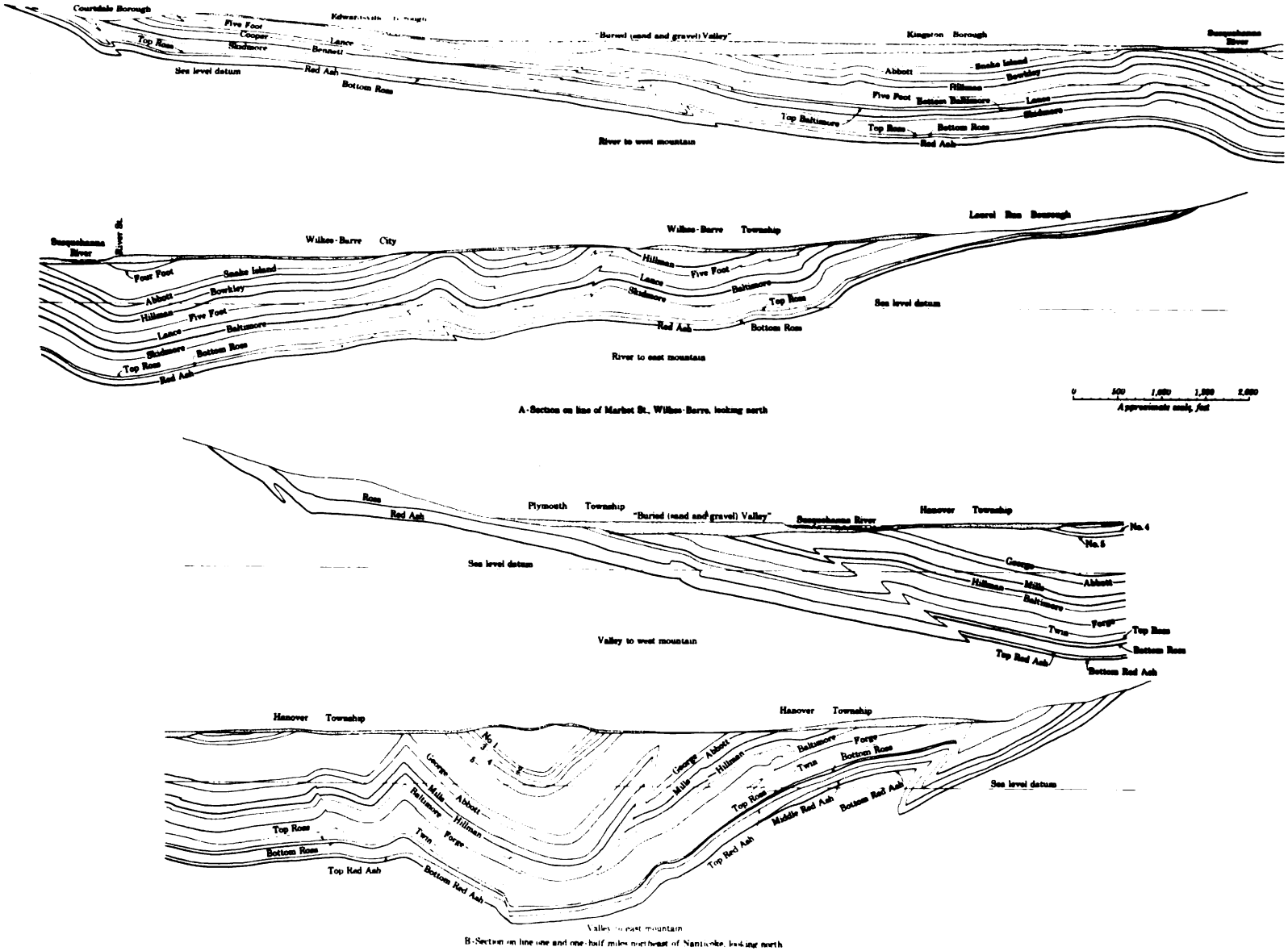


Figure 2.—Typical sections across coal beds of the southern part of the northern anthracite field.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

the major axis. Typical sections across the measures in the northern and central parts of the field are shown in figure 1 and in the southern part in figure 2.

The interval between seams ranges from a few feet to a maximum of about 200 feet and is occupied for the most part by gray sandstone, which makes a good roof and floor in undisturbed areas. Two seams have a fireclay roof from 2 to 15 feet thick, and occasional areas of shale roof are encountered.

Openings

The operations are relatively shallow, that is, largely within 1,000 feet of the surface. In a few places operations now extend as low as 1,600 feet below the surface and considerable future mining at and below this depth will be required. Surface elevations in the valleys, where most of the openings are range from 500 to 1,600 feet above sea level, with outcrop openings on the hills up to 500 feet higher.

Although many surface slopes, drifts, and tunnels are operated, the bulk of production is obtained from vertical shafts generally near the main basins or low-lying coal areas. Most of the operating shafts have four compartments - two hoisting compartments, a separate but adjoining air compartment used as an upcast airway, and a combination manway and pipe compartment. Some shafts at the largest collieries have six compartments, which include two pairs of hoisting compartments that operate on separate beds.

Although outlying air shafts have been required for the satisfactory ventilation of certain districts where operations on a number of seams extend distances of over 2 miles from operating openings, their number is comparatively few and their depth very limited. Surface openings in general are concentrated in a small area at each colliery.

Development

The various beds have been developed by double-entry levels, or "lifts", usually following the contours, at intervals of 200 to 300 feet along the dip, off surface shafts and slopes or off inside slopes, planes, and cross-measure tunnels. Most of the slopes and planes, originally driven double-entry, have been paralleled with chambers on each side, which now serve as return airways thus corresponding to a four-entry system of development in present ventilation systems. Few cross-measure tunnels have been required in the central and northern parts of the field except to facilitate haulage, and these have been driven single-entry usually in territory already completely developed and with ventilation established. In the southern part, many are required in developing new territory. Formerly these were driven as single openings but now they are advanced in pairs, one for haulage and intake air and the other, about 100 feet distant and 25 to 30 feet higher, for return air.

Generated on 2024-09-18 03:31 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

In addition to the cross-measure tunnels that interconnect the seams for haulage and ventilation, cross-measure rock planes, or "rock holes", are occasionally driven from seam to seam, usually on an angle of about 45° across the measures, for ventilation in the vicinity of faults, rolls and overlaps and to eliminate long return airways, particularly those in partly caved territory. In recent years an increasing number of cross-measure openings have been driven in the southern collieries to serve as main return airways.

Mining Methods

The coal has been and is being mined almost entirely by advancing chamber-and-pillar and breast-and-pillar methods, with wide columnized "reserve" pillars at regular intervals of 600 to 1,000 feet in the newer workings. Pillars are mined as a separate operation, retreating from boundary pillars, outcrops, and tops of anticlines. Over large areas the pillars are required for support of the overlying seams and surface and cannot be economically recovered immediately following chamber and breast or "first" mining.

A few sections on thin beds on light pitches are being mined by retreating methods - both chamber-and-pillar and short-face longwall. The latter method has been confined to pitches less than 6°. Development is essentially the same for retreating as for advancing operations, except that a pair of chambers is driven up at regular intervals between lifts for ventilation while the lateral development openings are being driven to their predetermined limits.

Except in parts of the southern end of the field, where the physical conditions of the deposits have delayed development, the thicker beds have been first-mined, and present operations consist mainly in extracting the pillars left by older operations, often in "squeezed" ground, and the first mining of beds less than 4 feet thick.

Details of mining operations and nomenclature vary mainly with the degree of the dip. Where the dip is less than about 12° the operations are termed "flat" workings and the coal is mined in "chambers". Operations on greater dips are termed "pitch" workings and the coal is mined in "breasts". In flat workings, the lower opening of the pair of development openings is termed the "airway" and the upper opening the "gangway". These are connected at close intervals by "crosscuts" - openings driven directly up the pitch - and at relatively long intervals by slant crosscuts or "sections" - openings driven on a slant across the pitch for haulage. Haulage is generally on the gangway only, but occasionally on both gangway and airway. In some very gassy operations only gathering haulage inby the last "section" is on the gangway and main-line haulage is on the intake airway. In pitch workings all haulage is on the lower opening or "gangway," from which narrow openings or "chutes" extend directly up the pitch on the center lines of the breasts. These are connected by "chute headings" to form an airway parallel to the gangway.

Generated on 2024-09-18 03:14 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Chambers and breasts are driven full width directly up the dip from the upper opening on 40- to 100-foot centers and 20 to 30 feet wide, the exact distances being determined mainly by the depth below surface and only occasionally by local conditions. Chambers and breasts are driven approximately up to but not through to the lower opening of the lift above. Connections between lifts are driven only as required for ventilation. Distances between lifts along the dip average about 300 feet in flat workings and about 200 feet in pitch workings. Occasionally, chambers or breasts are driven up opposite dips from both gangway and airway in a local basin, but these are always made separate operations, one being completed before the other is started. Chambers are connected at close intervals by crosscuts and breasts by headings - horizontal openings driven through the pillars. These two terms are interchangeable throughout the field, the former generally being used where flat workings predominate and the latter where pitch workings predominate.

Although mechanical mining with conveyors, shaker chutes, and scrapers is being used to a rapidly increasing extent in flat workings on the thinner seams, hand loading into cars at the face of the chamber or pillar is the general practice. On pitches of 12° to about 30°, sheet-iron plates and sheet-iron chutes are used to convey the coal to the gangway, where it is loaded into the car from a platform installed in the chute. Where the pitch is over 30°, the chute opening is equipped with a storage pocket with a draw-chute at the gangway. Unless the pitch is more than about 50°, the coal is allowed to fall down through the breast, the fall being retarded as required by cross-timbers or "batteries." Where the pitch exceeds about 50°, the coal is stored as broken in a lagged-off section or "box" carried up in the center of the breast. In this "box-pitch" method the excess coal falls down through narrow manway openings carried up along each side of the box. The box remains full and provides a footing for the miners at the working face until the breast has been driven up to its limit; later, the loose coal is drawn from the full box into the chute pocket at the gangway and is loaded into cars from a draw-chute.

Pillars are mined by taking successive slices or "skips" off the upper end and allowing the roof to cave. In flat workings, a narrow roadway is cleaned up along one side of the pillar, or, in caved areas, a roadway is provided by taking up a narrow slice along the rib. Skips are taken diagonally across the width, with the roof temporarily supported by props and timber cogs as required. Where such support fails and the roof caves against the pillar face, a narrow opening or "split," about 6 to 10 feet wide, is driven diagonally through the pillar a short distance from the face. The stump pillar thus formed is recovered by successive skips starting from the upper side of the split. In mining pillars on the lighter pitches, similar methods are used in conjunction with a sheet-iron slide or chute along one rib. On the heavier pitches, the same procedure is followed where feasible, but more commonly a narrow opening or "split" is driven from the gangway up through the center of the pillar, and the coal is mined by successive diagonal skips off the top on both sides of the split, the coal falling down the split to the gangway.

Generated on 2024-09-18 03:14 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

In collieries that have flat workings on thick seams, large areas have been 'silted', or filled with culm by hydraulic methods, but as yet there have been few instances of pillar extraction in such sections.

Operations are mainly on an open-light basis in the northern and central areas of the field, in that very little gas is encountered in the northern part and in the central part operations have been so extended that the beds have been nearly drained of gas. However, certain beds in a number of these collieries are on a closed-light basis, as are practically all of the southern collieries. In these, approved types of electric cap lamps are used for illumination and approved types of flame safety lamps are used for testing for gas. In some of the open-light operations, the miners are provided with approved types of flame safety lamps for testing for gas, and in these sections there is the same fire-boss inspection as in closed-light sections.

Main-line haulage underground is by trolley locomotives. Gathering haulage is mainly by cable-reel and storage battery locomotives. Mule haulage is being eliminated gradually.

Except in the longwall operations and some chamber mining in thin seams where the coal is undercut by machines, the coal is blasted off the solid by means of black powder, pellet powder, or permissible explosives. Single-shot blasting is used in hand mining, and multiple-shot blasting, with a maximum of 12 shots per blast, in mechanical mining. Most of the firing is done with electric blasting batteries, although in a few sections the older methods still prevail.

VENTILATION METHODS

Carefully supervised distribution systems for maintaining proper ventilation are required for the dilution and removal of powder smoke in all operations and for the prevention of accumulations of methane in many. Except in the southern part of the field, few places that are very gassy are encountered in present operations, but the possibility of a dangerous accumulation is always present in certain beds and ample continuous ventilation is required. In the gassy southern collieries every precaution is required during chamber and breast mining to prevent short-circuits of the ventilating currents, as most places rapidly fill with gas when the air supply is cut off or diminished considerably. All openings are ventilated 24 hours a day.

Although beds in which first-mining has been completed have become relatively free from gas, particularly those near the surface, nevertheless a rigid control of ventilating currents is required during pillar-mining operations, as gas is often liberated unexpectedly in these workings. Where the mining is in caved areas the attainment of this object is difficult.

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Distribution Systems

The general method of ventilating is by exhaust fans installed on the surface. Most of them are at or close to the operating shafts and slopes and exhaust from the separate upcast compartment of the shafts, an upcast slope airway, or a separate upcast air shaft. A few are installed at outlying upcast air shafts. The intake air enters through the hoisting compartments of shafts and haulage slopes and tunnels, supplemented by a few outlying outcrop openings and shallow air shafts. All hoisting and main haulage is on intake air currents that have not passed through active working places.

A general method of coursed ascensional distribution is followed; intake air is coursed directly from the surface to active development faces, then passes up through active chambers or breasts and across the highest elevations of first-mined sections to the main returns, through which it ascends to surface. Sectional returns, particularly in the case of workings off tunnels and planes, must often be downcasted short distances to main returns. First-mined territories that are ventilated with the returns from active sections are so extensive that large quantities of air are required, for which separate return airways must be provided in many cases. To an increasing extent these are taking the form of inclined rock planes driven up across the measures at about right angles to the dip to upper seams, and provide main returns that eliminate much of the necessity for downcasting return currents as well as shortening the distances traveled.

In some of the older operations the intake air is coursed through inactive workings and higher elevations on the way to active workings, through which it descends to development faces and returns through the lower development opening. With the general introduction of electric haulage, this method is being discarded gradually, when this can be done economically. Although there is the advantage of a small consumption of power in the new method of ascensional local ventilation, the chief advantages are the lower gas content of the air supply to active faces, greater safety, and faster haulage due to the fact that fewer doors and attendants are required.

The number of lifts or separate working sections on a split depends largely on gas conditions and convenience, in addition to the necessity of keeping the number of men employed within the legal limit of 75. Almost invariably gassy sections are on separate splits. Pillar-mining sections almost invariably are on splits that are separate from first-mining sections. Where conditions prevent such a layout, the air is coursed through the first-mining section and then through the pillar-mining operation, as experience has shown that the breaking of the roof following pillar-mining sometimes liberates gas in sections that were free from it in first-mining operations.

Major Outlines of Distribution Systems

Most large collieries have two or more separate ventilation systems, usually with the division between groups of beds. An attempt is made to provide a separately ventilated district or group of beds for each mine foreman,

Generated on 2024-09-18 03:13 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

so that each has entire control of the ventilation in his own section. Occasionally, as a matter of necessity, an outlying section of one colliery is ventilated by a split of air coursed from an adjoining colliery.

On account of the extent of the workings at most of the collieries and the number of interconnected beds, complete outlines of the ventilation systems can hardly be shown to advantage by small-scale maps or diagrams. Typical diagrammatic ventilation maps for single beds are shown in figures 3, 4, and 5; figure 3 shows older workings in an irregularly contoured bed, figure 4 more recent operations in a more uniformly contoured bed, and figure 5 recent operations on a relatively uniformly contoured trough. Each large colliery has a dozen or more major air splits and from 30 to 150 minor splits.

Minor Outlines of Distribution Systems

Except in caved or crushed territory, where the details must be adjusted to the conditions obtaining, well-defined methods of coursing the air through the active and inactive workings are in use. In the relatively flat and nongassy beds of the central and northern parts of the field, the methods closely resemble those used in bituminous mines. The intake air comes in the airway, is coursed around development faces by line brattice, and then through the active chambers in series through the last or open crosscuts and connections between lifts to inactive workings, through which it is coursed or broadcast to the returns. Generally adopted methods are as shown in figures 4 and 6. Where conditions as to pitch or gas require it, additional check doors are erected on the gangway, or the chamber entrances may be closed by brattice doors or curtains, and occasionally line brattice is used for both chamber and longwall faces. In places the gob is so disposed as to provide openings similar to those provided by line brattice, and a few curtains suitably disposed hold the air to the faces. The slant openings or "sections" from gangway to airway are used only for haulage from the airway development and are walled off as they become inoperative. Although the gangways used for haulage are shut off by airlock doors, the leakage is sufficient to ventilate them with intake air.

In low coal, the two end crosscuts between gangway and airway or through chamber pillars are often left open, with the line brattice (if any is used) extending from the second last crosscut, in order not to "choke" the air current. For the same reason the dry-wall stoppings in the crosscuts near the development faces are not made tight by plastering, as considerable leakage across the gangway and up through the chambers is desired in the section that is active.

In the southern part of the field the beds are gassy and on moderate to steep pitches, and detailed coursing of the air currents to all working faces is required. Line brattices are carried to all faces, inactive chambers are closed off near the gangway with wall stoppings or board brattices, and active chambers with brattice doors or canvas checks reinforced with occasional check doors or curtains on the gangway. In mechanical systems, where the gangway is not in use for car haulage, brattices are erected

Generated on 2024-09-18 03:11 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:11 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

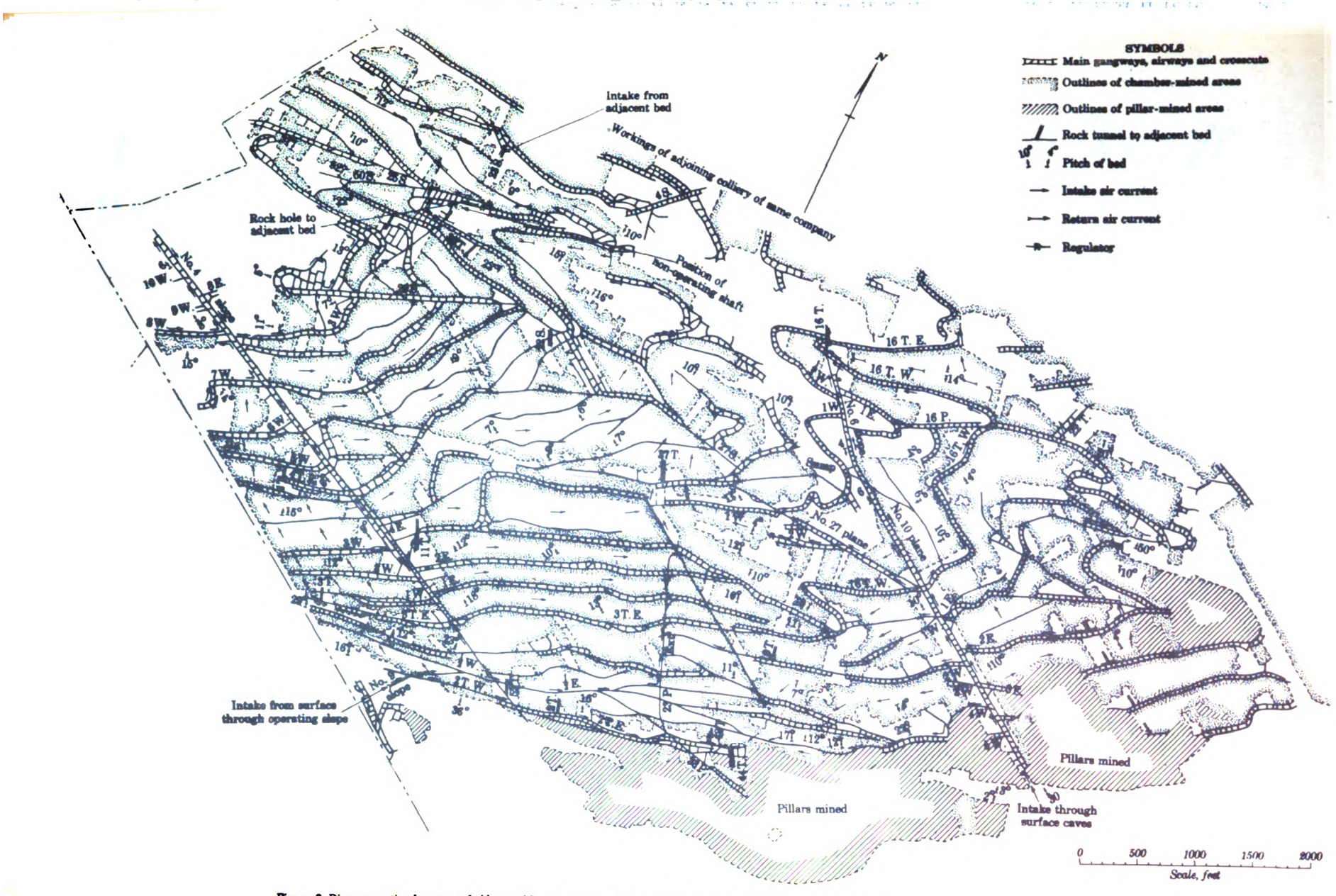


Figure 3.-Diagrammatic plan map of older workings in an irregularly contoured bed, showing distribution of air currents.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

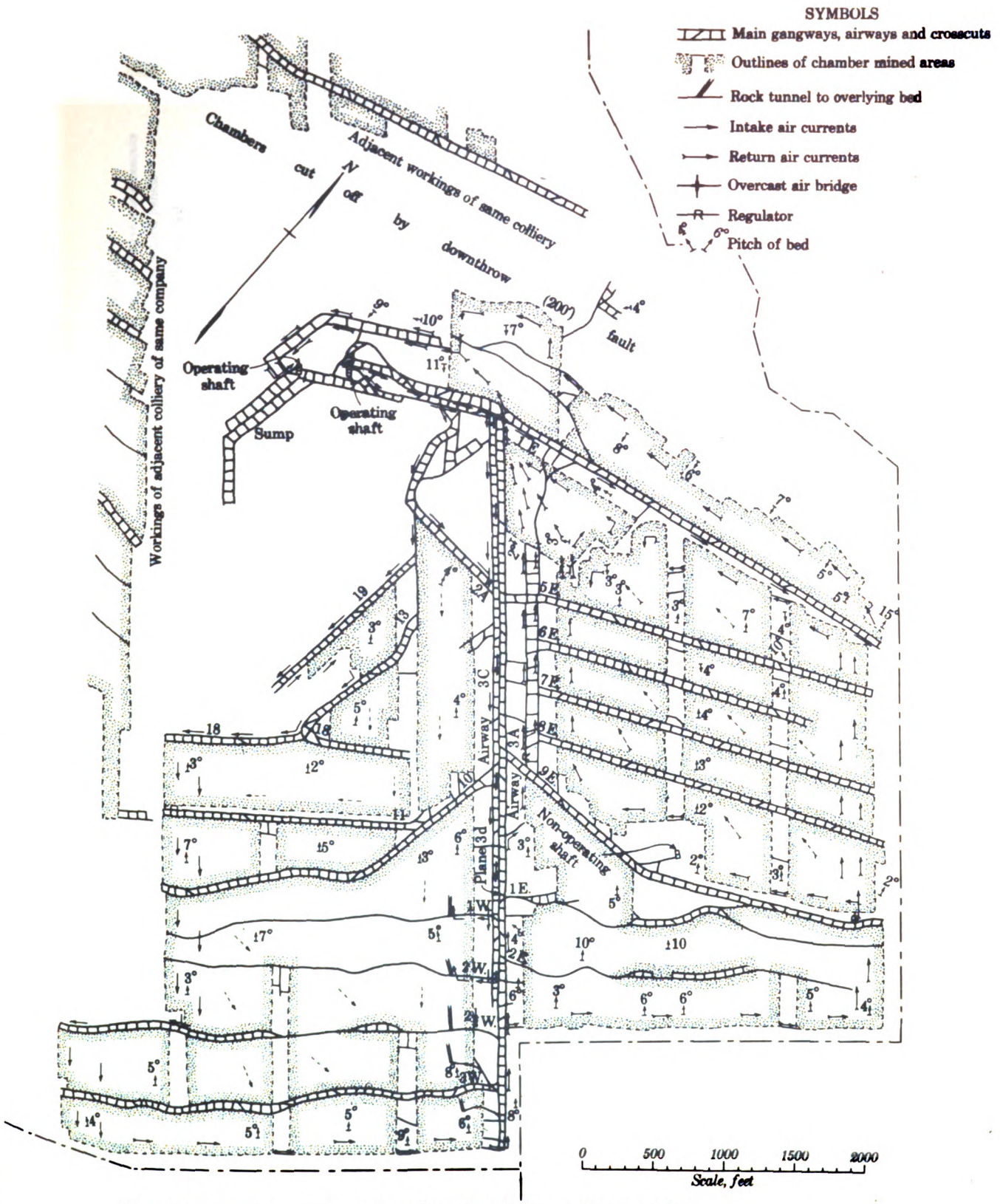


Figure 4 -Diagrammatic plan map of recent flat workings in a regularly contoured bed, showing distribution of air currents.

Generated on 2024-09-18 03:11 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:14 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

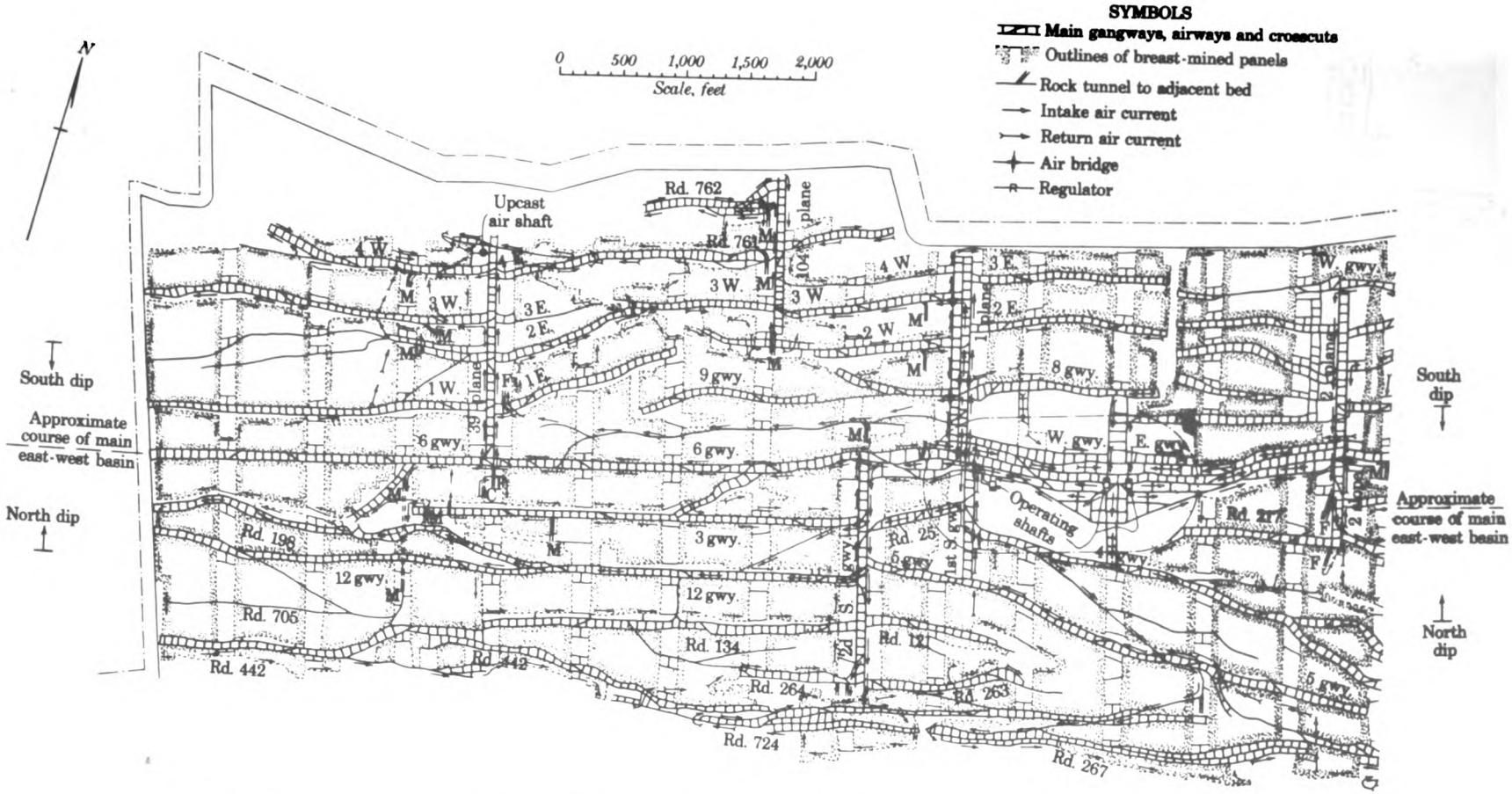


Figure 5.—Diagrammatic plan map of recent pitch workings on a regularly contoured trough, showing distribution of air currents.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:10 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

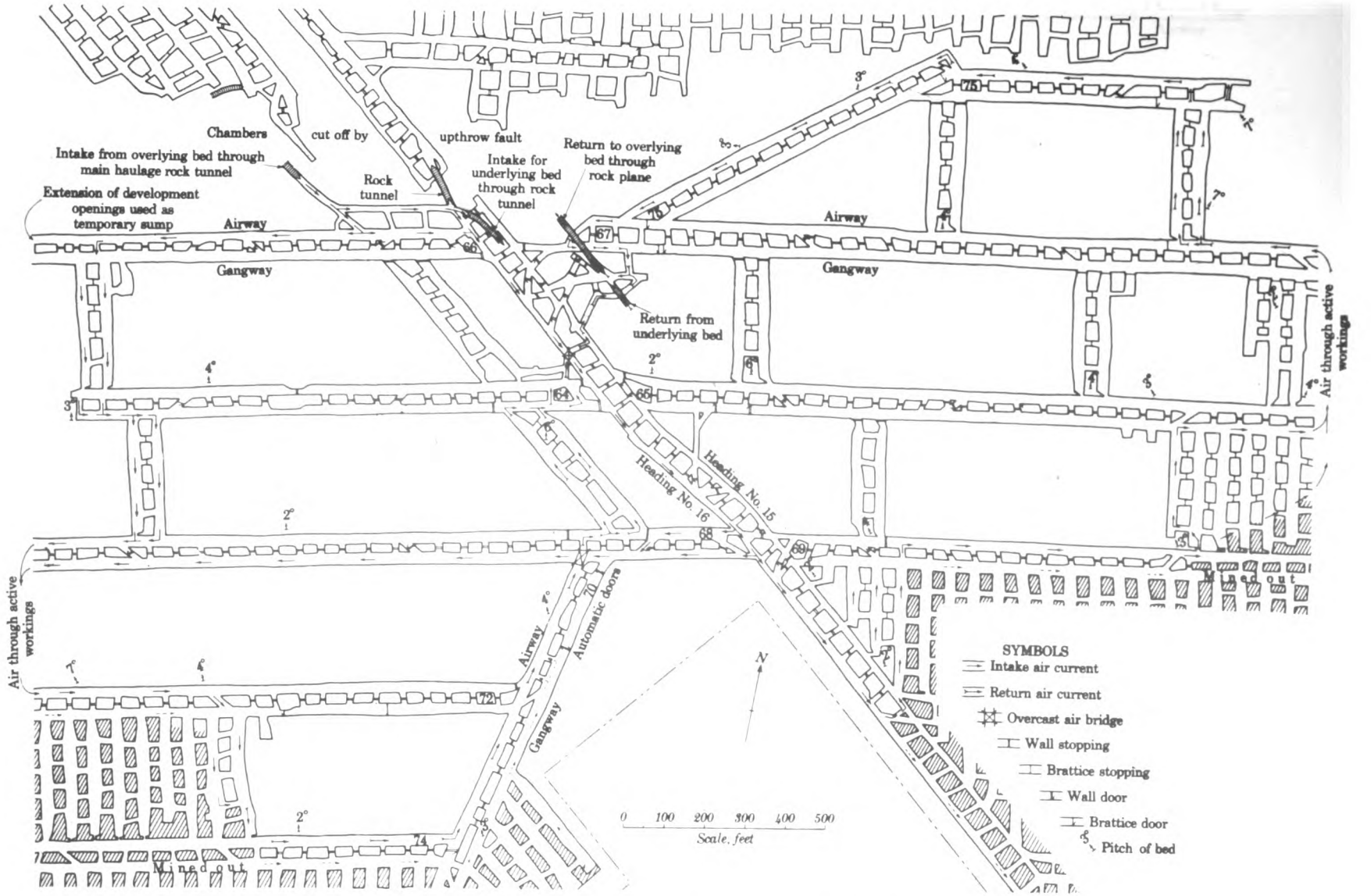
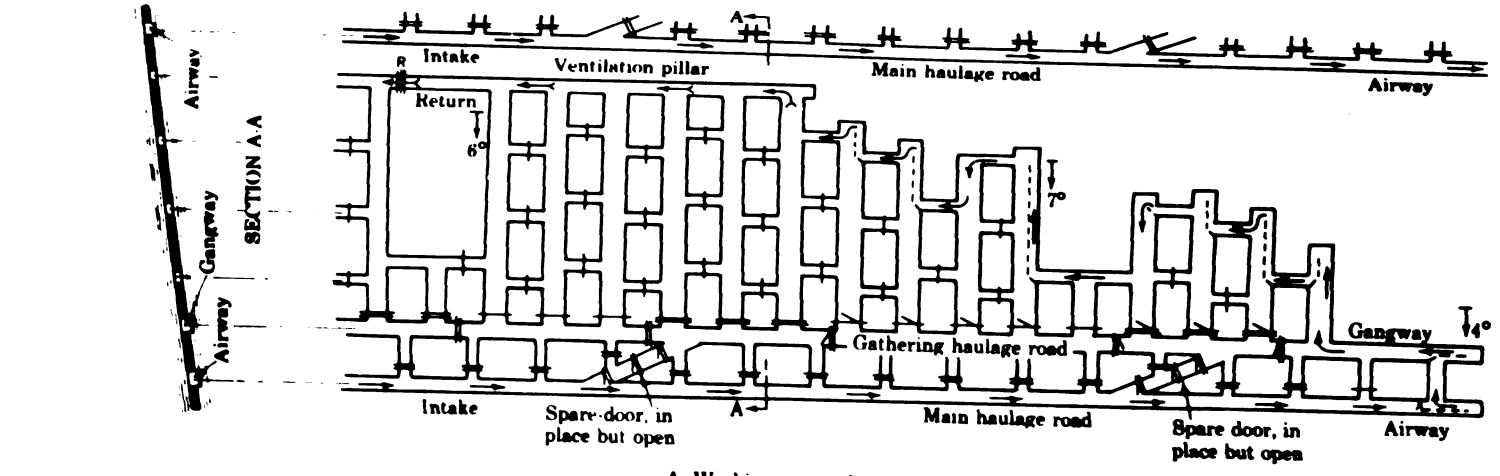


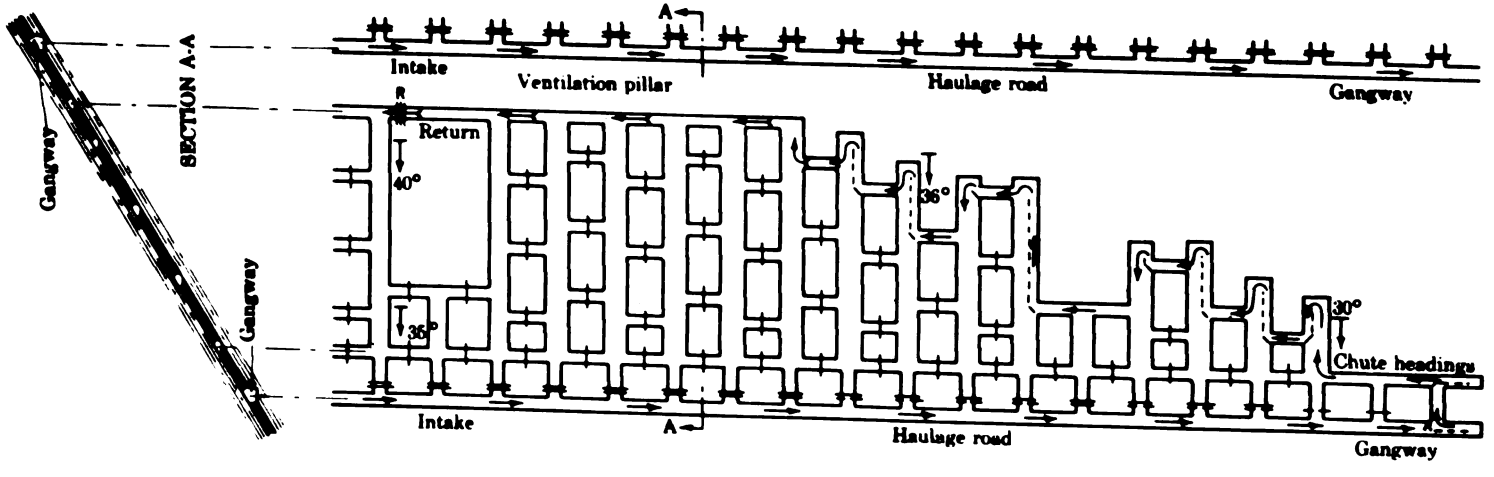
Figure 6.- Plan map of workings in a relatively flat and non-gassy bed showing method of distributing air currents in retreating system of chamber and pillar mining.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google



A - Workings on moderate pitches



B - Workings on steep pitches

SYMBOLS

Intake air current
Return air current
Line brattice
R
Regulator
Wall stopping
Brattice stopping
Wall door
Brattice door
Wall stopping with chute and manway openings

Figure 7.- Sketches showing methods of ventilating gassy workings.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

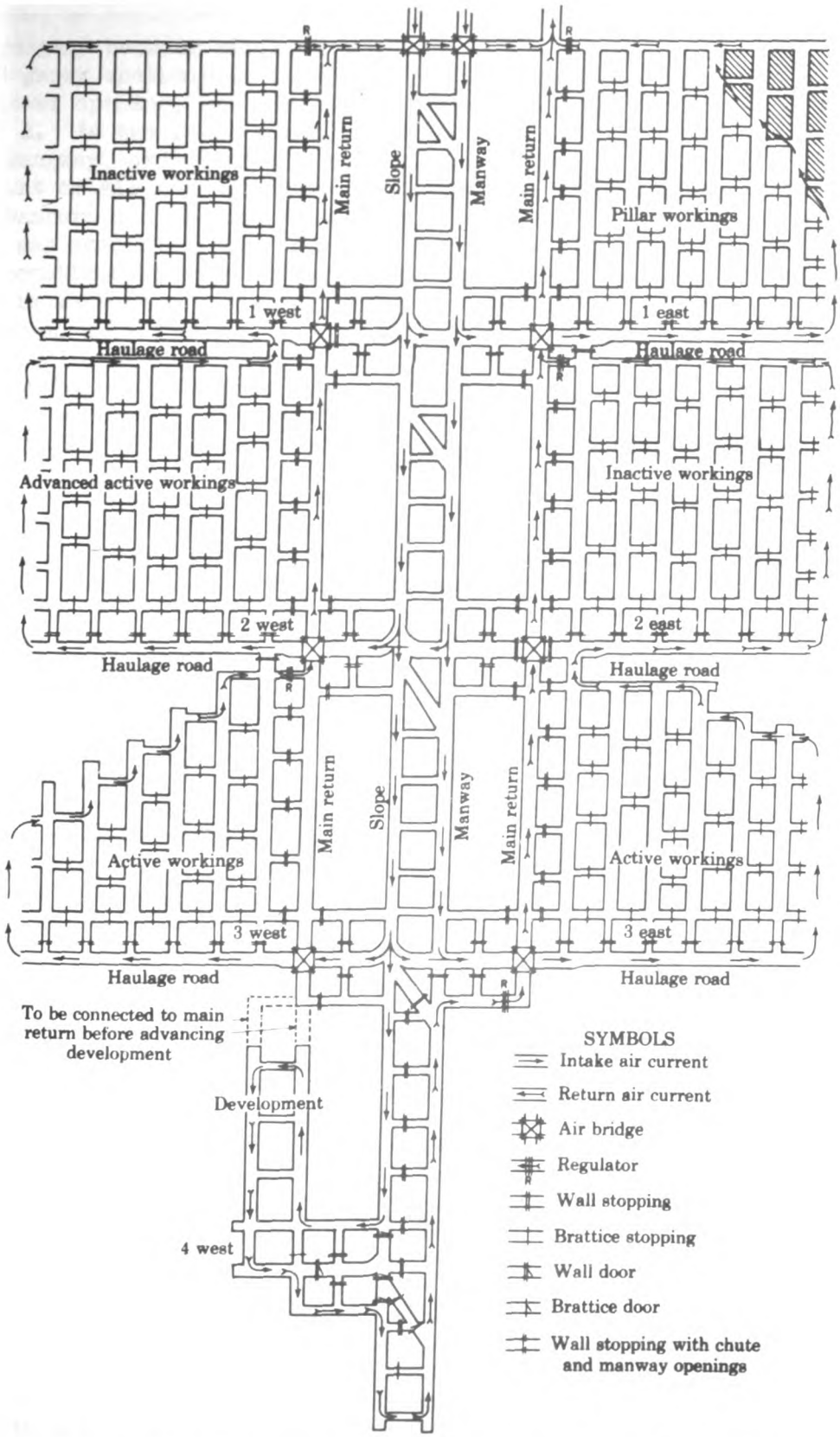


Figure 8.- Sketch plan showing method of ventilating slope workings and development.

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

on the gangway between chambers rather than across the chamber. In many of the most gassy operations, however, the main haulage is carried on the airway or lower opening, and the distribution in active ends is as shown in figure 7 A. As the faces advance, the slant haulage openings between airway and gangway, or "cut-offs", become inoperative and are walled off. A certain amount of air must be allowed to leak or "screen" across the lower parts of the chambers and through closed-off sections of the gangways to keep them clear of gas accumulations. The amount required is small, but the actual leakage sometimes becomes so excessive that the ventilation of active face sections is dangerously reduced. Such a condition is usually remedied by tightening up a line or two of the brattice stoppings in the pillar headings; occasionally it is necessary to "run up a tie", that is, to replace a line of wooden brattice stoppings in one pillar with a line of tight-wall stoppings.

The generally adopted method of distribution in gassy "pitch" workings is quite similar and is sketched in figure 7 B. Air splits to pitch sections are usually smaller in volume and under higher pressure than those in flat sections. Here the haulage is on the lower road or "gangway" only. The stoppings in the chute headings are wall stoppings but cannot be made entirely tight as long as the breast is active, since openings must be maintained for passage of coal and men. The necessary openings are made as small as possible and are covered with canvas flaps or closed by trapdoors. As soon as a breast is completed, the openings in the chute stopping are walled up so that a maximum flow can be maintained across the active working faces.

As the pitch increases, more attention is devoted to making the brattice stoppings tight in the pillar headings between breasts. In "box pitch" breasts, where a narrow manway is carried up on both sides of a lagged-off central section of the breast and excess coal falls down these manways, it is very essential to keep the manways clear of obstructions at all times, as an obstruction above the last heading shuts off the air supply to the face and one below it may result in a gas accumulation below the obstruction.

The general method of distribution in gassy pitch workings off a slope is shown in figure 8. Each active lift on each side, as well as the bottom development, is on a separate split, and inactive lifts are ventilated by the returns from the active sections. Each pillar-mining section is also on a separate split. In all initial development work, such as extending the slope an additional lift, the major requirement is that no active production be attempted or allowed until all of the openings required for ventilation have been driven and connected, all control features have been installed, and all potential hazards from doors and temporary brattice stoppings have been removed or reduced to a minimum. Where potential hazards may exist due to special conditions during the development period, it is customary to delegate a watchman to insure positive control of the air currents at all times.

Practically the same method of development is required for workings off planes as for those off slopes, except that the development proceeds up the dip instead of down. Although the local ventilation is ascensional in such workings, the main returns must often be brought back down the dip to existing return airway connections, at least until such time as return connections can be had at the higher elevations.

Generated on 2024-09-18 03:13 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The common method of developing an adjacent gassy bed by rock tunnels is indicated in figure 9. Here, again, the major requirement is that the openings required for ventilation be completely connected and all control features installed before opening the bed for production. The exact details of procedure vary somewhat with existing conditions, particularly with the degree of the dip, relative closeness of beds, and extent of the territory opened; three stages are shown for the conditions selected.

The generally adopted method of developing new territory off parallel rock tunnels that intersect a number of pitching beds is indicated in figure 10. By driving one tunnel at a higher elevation than the other, natural overcasts are formed at the intersections with the beds and one very expensive feature of distribution control is eliminated.

A variation of the method shown in figure 10 is that sketched in figure 11 as applying to beds close together. Here, short rock planes or "rock holes" are driven to connect the beds and serve as return airways.

The general method of ventilating moderately gassy pillar-mining operations is indicated in the upper part of figure 8. Sometimes the brattice stoppings placed in the headings during chamber or breast mining are in fair condition and serve to keep the air currents sweeping the working faces, but generally the brattice stoppings are rotted away and it is necessary to carry up a new line or "tie" of brattices about every third pillar to keep the air currents sweeping the faces. In nongassy operations the air currents are merely "broadcast" through the pillar-mining area.

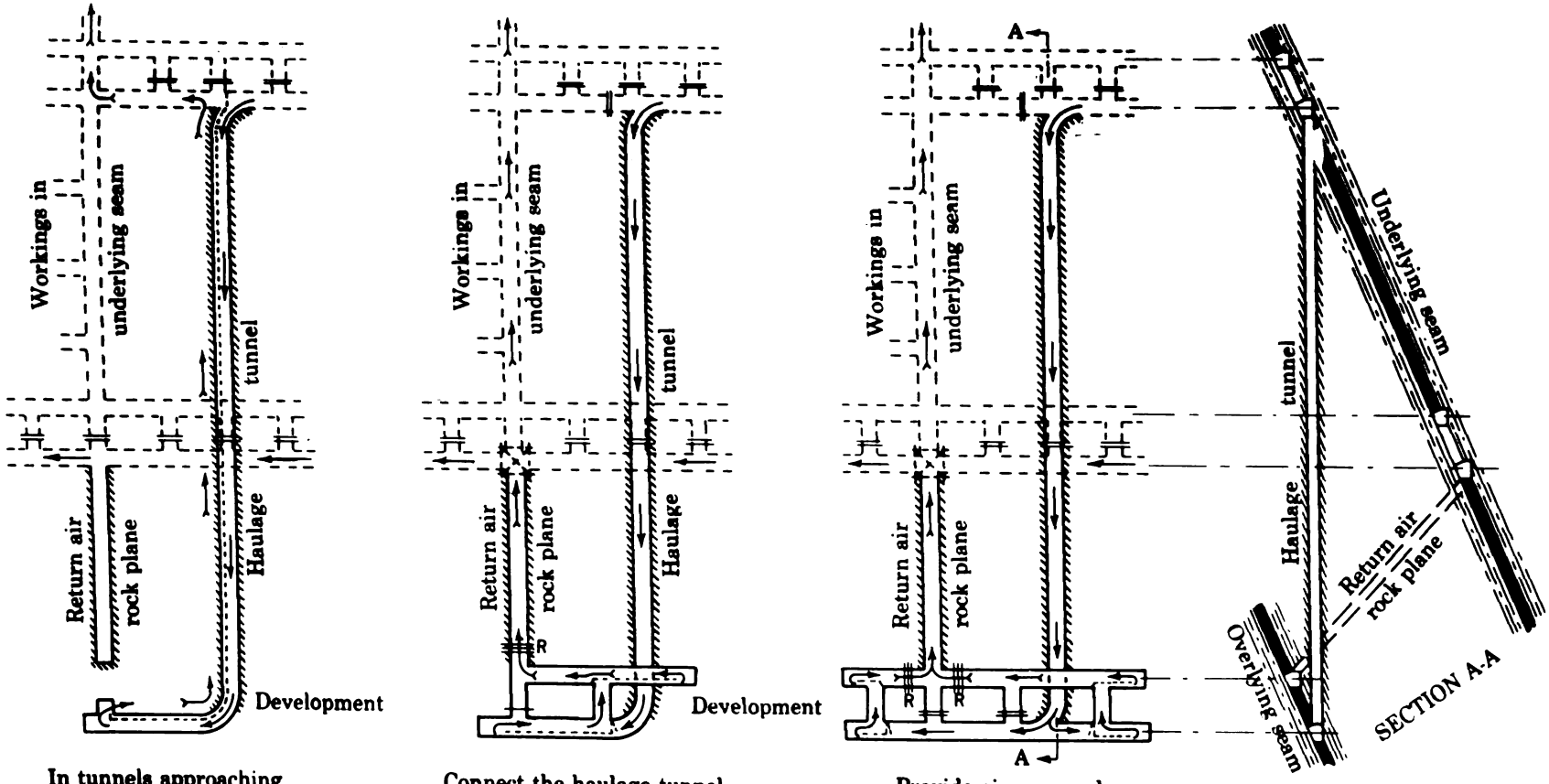
All electrical installations, such as pump motors, hoist motors, generators, transformers, and battery-charging stations, are placed on or adjacent to intake airways. These are ventilated by a separate small split going direct to a return airway, while some, particularly those on main intake airways, have special provisions for quickly short-circuiting a large flow through the installation to a return airway in case of fire.

Fan Installations

With few exceptions, the fans are large centrifugal types installed on the surface which exhaust without having reversing arrangements. Above Wilkes-Barre a large majority are late type Guibals installed prior to 1910, whereas at and below Wilkes-Barre the majority are forward-curved multiblade fans installed since that date and, in many cases, which replace old Guibals. There are a few old disk-fan installations and a number of very recent propeller installations, both single- and double-stage. While most of the operating Guibals are late types 20 to 35 feet in diameter with double inlets, full-scroll and backward-curved tips on backward-sloping blades, some few are single-inlet type, and many installations now used only in emergencies, as well as some that are operated continuously, are 40 to 50 years old and represent very early types. One particularly interesting type, of which there are at least three still standing, is the Schaar "Double" Guibal, consisting of two Guibals of conventional double-inlet type mounted about 8 feet apart on a common shaft with a pulley, for belt drive, centered between

Generated on 2024-09-18 03:11 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google



In tunnels approaching gaseous seams, provide a concrete line brattice connected to a return airway with haulage on the intake side of the brattice

Connect the haulage tunnel to a return tunnel and provide necessary air bridges and stoppings before advancing development

Provide airways and connections for primary ventilation splits before continuing development for production

Note: For symbols see Figure 8

Figure 9.- Sketch plans showing three stages in the developmont of an overlying seam by rock tunnels, and the corresponding methods of ventilation to be employed.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

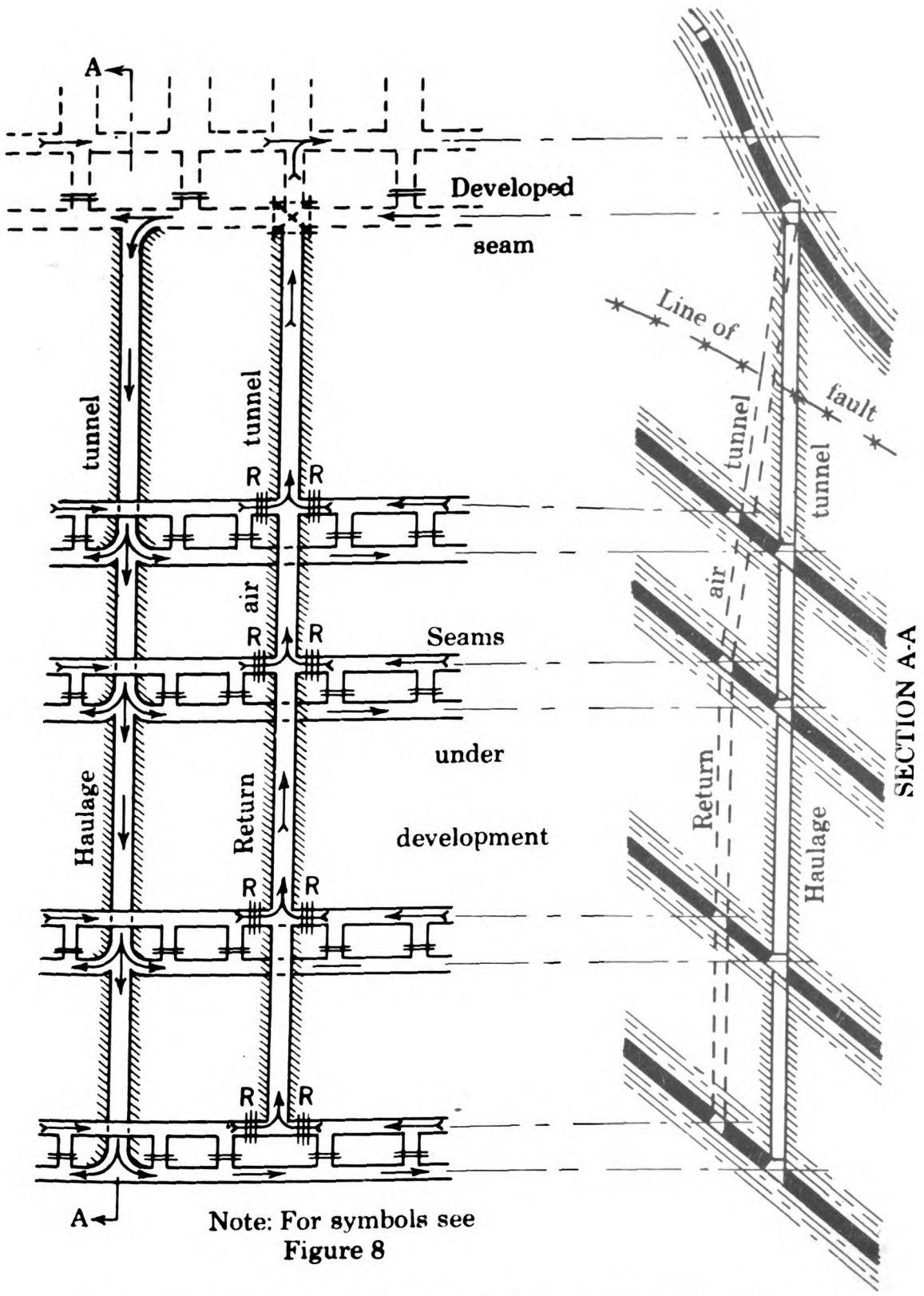


Figure 10.- Sketch showing method of ventilating development from parallel tunnels.

Generated on 2024-09-18 03:11 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
THE OHIO STATE UNIVERSITY

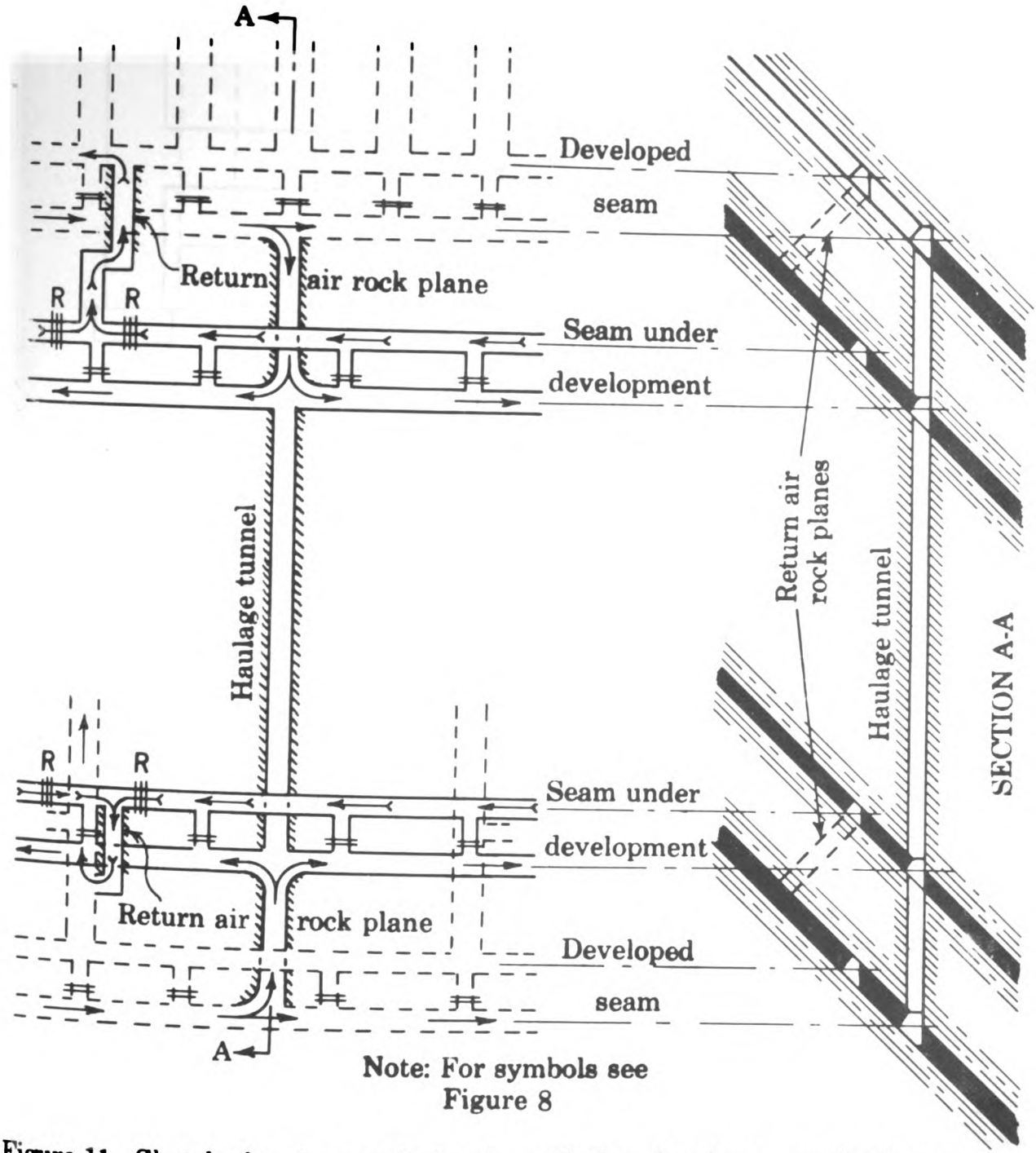


Figure 11.- Sketch showing methods of ventilating development of adjacent seams by short rock plane return airways.

Generated on 2024-09-18 03:15 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

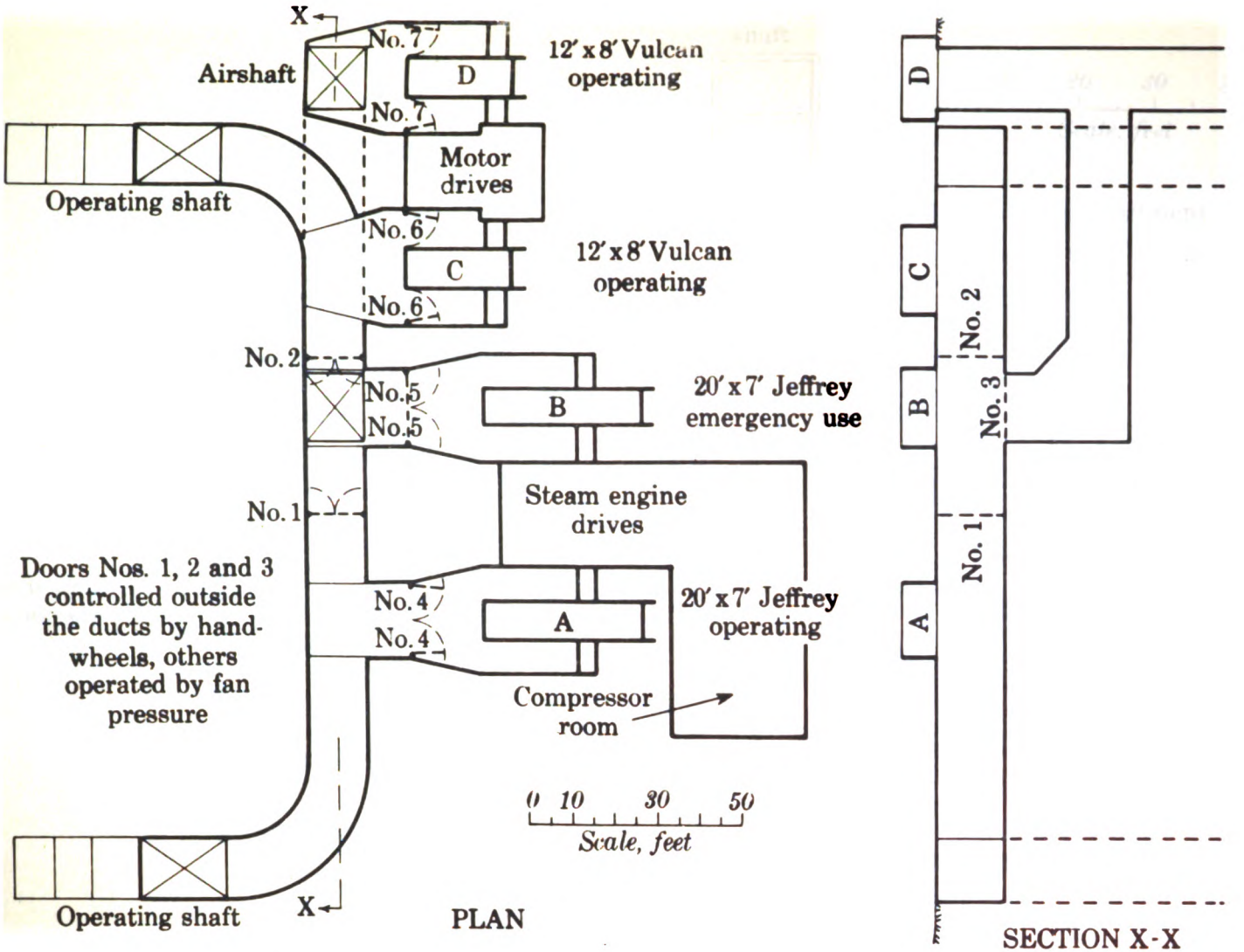


Figure 12.- Diagram showing general arrangement of fans, ducts and doors of "nest" of four fans.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:14 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

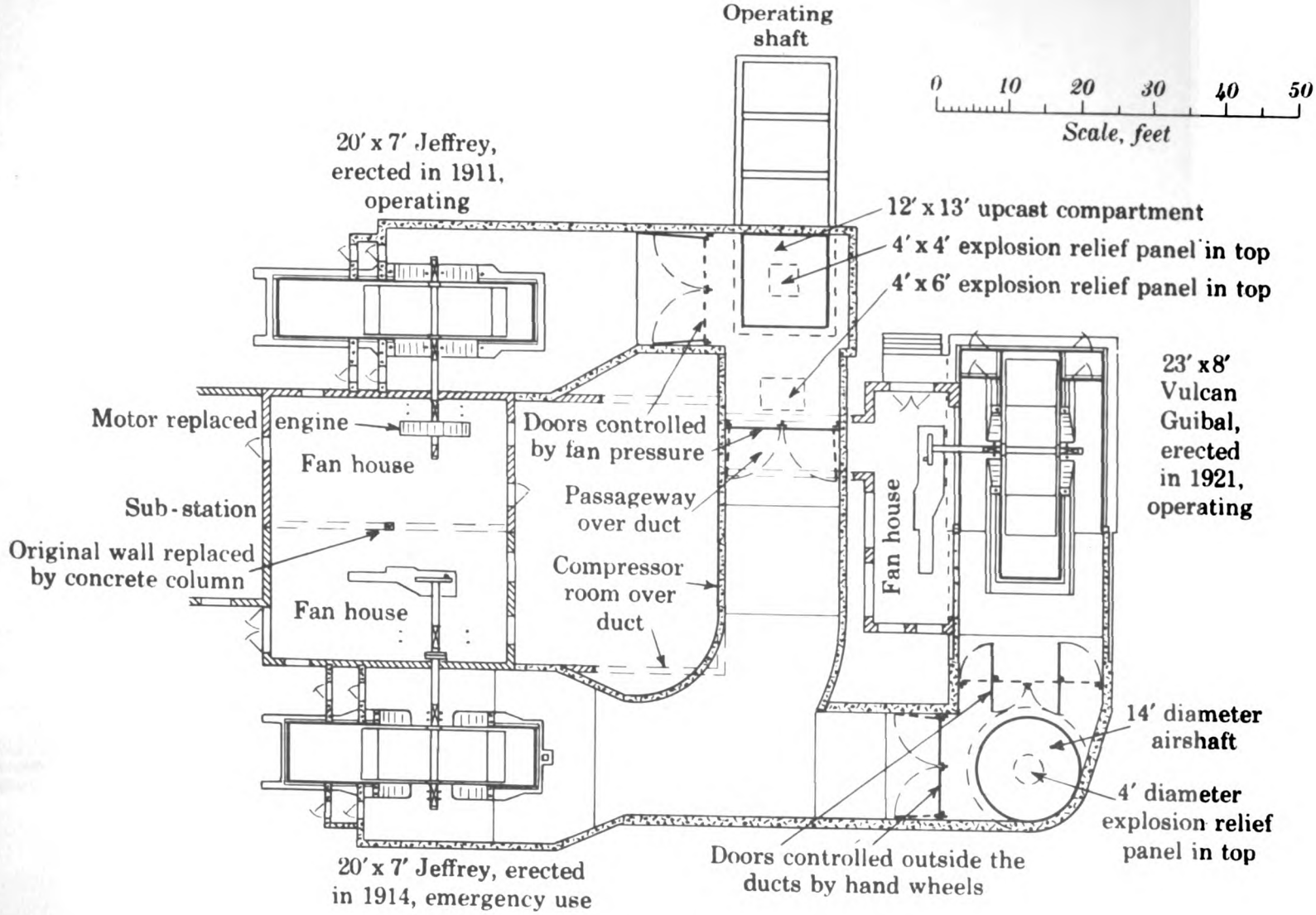

Operating shaft
0 10 20 30 40 50
Scale, feet
20′ x 7′ Jeffrey, erected in 1911, operating
12′ x 13′ upcast compartment
4′ x 4′ explosion relief panel in top
4′ x 6′ explosion relief panel in top
23′ x 8′ Vulcan Guibal, erected in 1921, operating
Motor replaced engine
Fan house
Doors controlled by fan pressure
Sub-station
Passageway over duct
Original wall replaced by concrete column
Compressor room over duct
Fan house
Fan house
14′ diameter airshaft
4′ diameter explosion relief panel in top
20′ x 7′ Jeffrey, erected in 1914, emergency use
Doors controlled outside the ducts by hand wheels

Figure 13.- Plan on center line of fans and air ducts, of "nest" of three fans.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

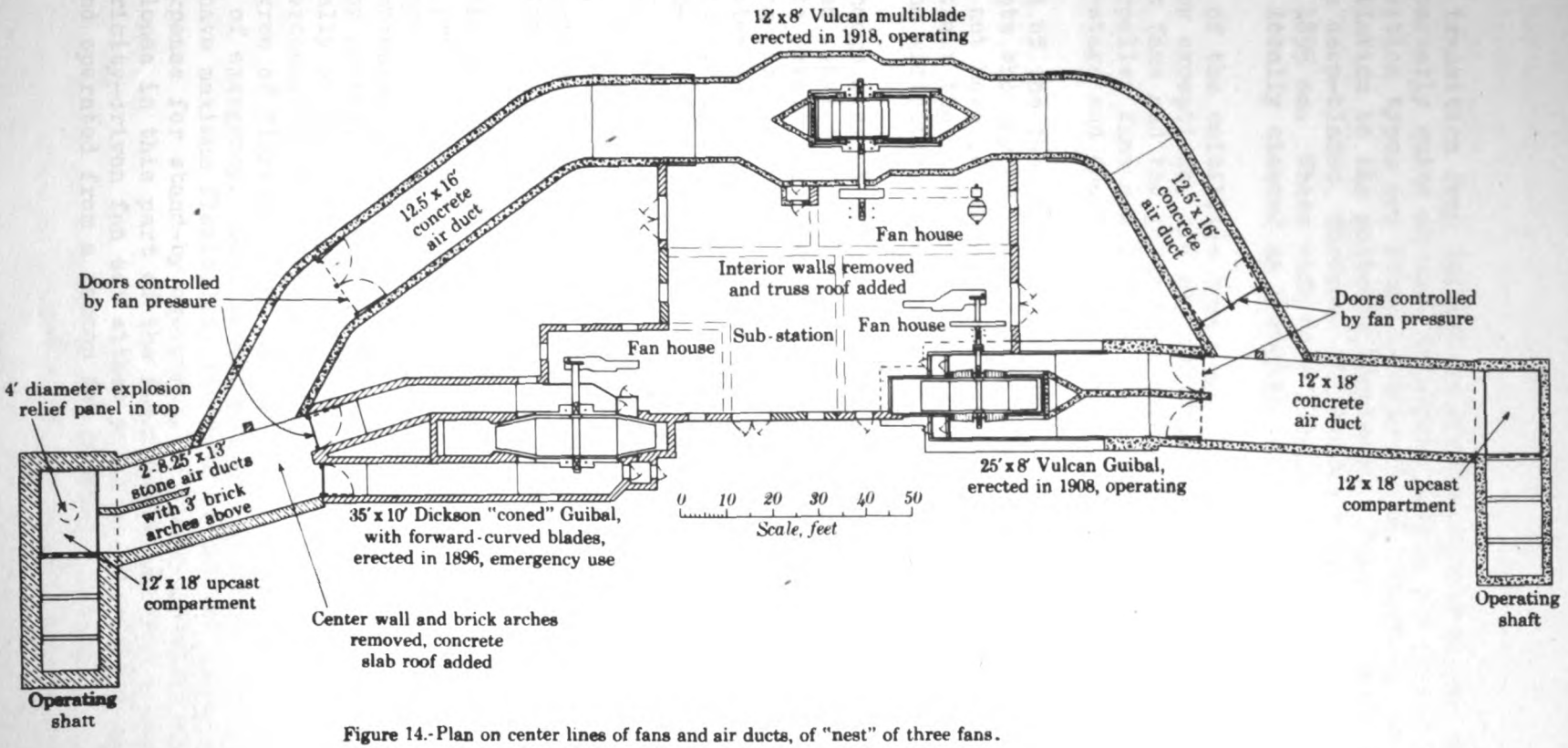


Figure 14.-Plan on center lines of fans and air ducts, of "nest" of three fans.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

them.

The transition from Guibals to shallow-curved-bladed multivanes was apparently quite abrupt, occurring during the period 1910-1912, and few transition types are found in this field. There is but one Capell installation to the author's knowledge. However, there are a dozen or more deep-bladed, forward- and backward-curved, 16-blade fans installed from 1895 on. These were made locally by manufacturers of Guibal fans and are locally classed as Guibals.

All of the multiblade types have forward-curved blades and, with relatively few exceptions, are stepped-blade types, the older ones being mostly Vulcan fans and the later ones Jeffrey fans. All of the recently installed propeller fans are Jeffrey Aerovanes, about evenly divided between single-stage and double-stage designs.

Most of the fans are grouped close to operating openings and have attendants who may or may not have other duties to perform nearby. Fans that do not have assigned attendants are equipped with a signaling device to attract the attention of designated employees at fixed points of duty in the vicinity whenever the fans cease to operate.

Although most of the older fans were originally steam-driven, many have been converted to electric drive for "stand-by" service in emergencies and to permit the closing of steam plants during idle periods. During working periods, steam drive is generally used for main fans at the large collieries and electric drive only for outlying installations and small operations. At certain collieries, arrangements have been made to operate steam-driven fans by electrically-generated compressed air, thereby permitting steam plants to be shut down during inactive periods. In the northern and central parts of the field, stand-by protection is afforded mainly by duplicate steam-drive arrangements or by having both steam and electric drive available. At many collieries there are underground facilities for combining distribution systems in emergencies.

In the southern and more gassy part of the field, arrangements for stand-by protection are made at practically all fan installations by having at least one steam-driven and one electricity-driven fan, or both steam and compressed-air drive for one fan of a duplicate steam-driven unit. At many places, fans are installed in "nests" of three or four and operate normally on two or three separate circuits, but with the separate circuits interconnected with door-controlled ducts so as to allow a considerable degree of flexibility in the method of operation of individual fans in case of emergency. Such installations, as shown in figures 12, 13, and 14, have maximum flexibility for both normal and emergency service at minimum expense for stand-by equipment. In most installations at other shafts and slopes in this part of the field there are both a steam-driven and an electricity-driven fan set either parallel or at right angles to each other and operated from a common fan house.

Generated on 2024-09-18 03:10 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

A late type of layout for outlying fans is represented in figure 15. In this installation stand-by service is provided by a gasoline-engine-driven fan automatically interconnected with the motor-driven fan, so that whenever one stops the other automatically starts. In a somewhat similar installation at another colliery the main fan is motor-driven and the stand-by fan is also motor-driven, but the latter is operated by a direct-current generator set driven by a gasoline engine, which automatically starts when the main fan stops.

Fan Performances

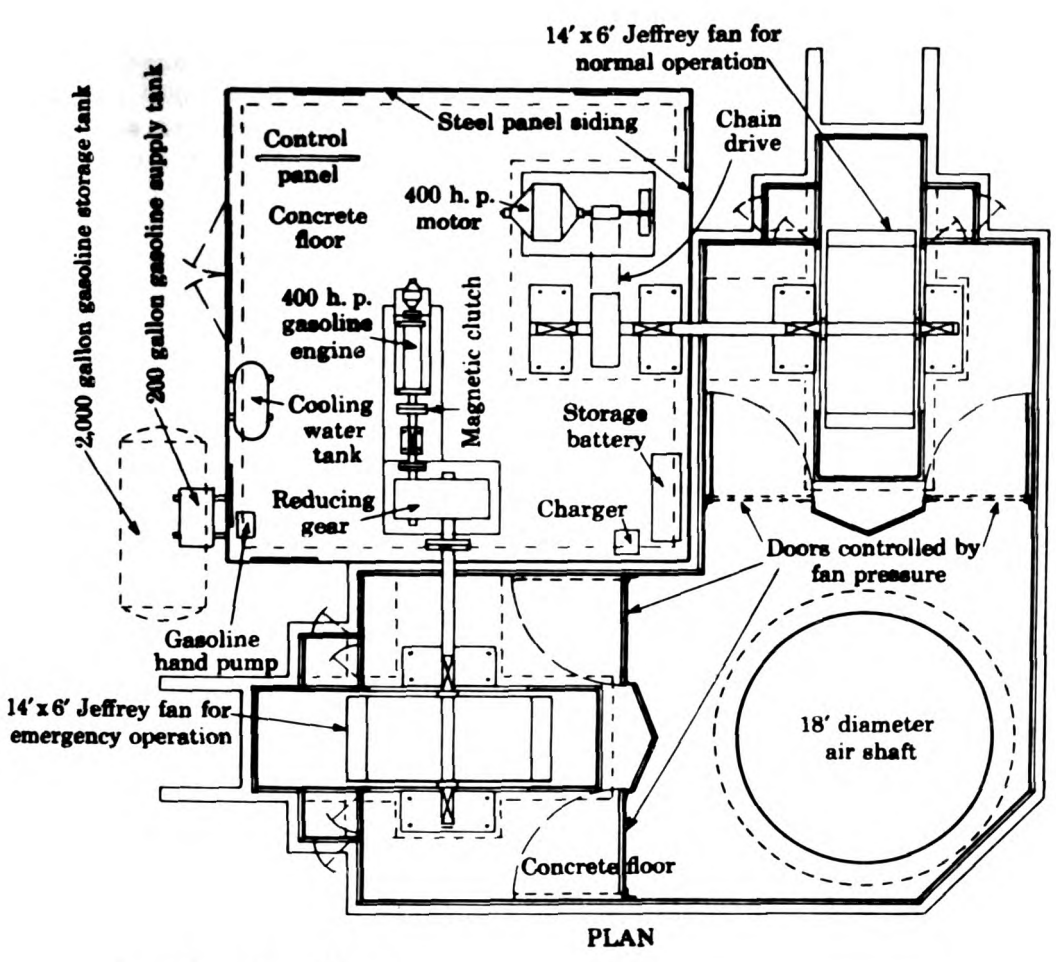
Most of the fans now in use were installed years ago when very little technical data on fan performance were available, and few changes have been made in recent years. Fan types and sizes were selected largely on a basis of previous personal experiences and probable future conditions of extension of operations over a long period of years. Attention has been concentrated mainly on changing the distribution to cope with changes in operating conditions. In most of the field ventilation requirements have decreased gradually over a period of years and most of the fans are now much too large for the service demanded of them, and thus operate at efficiencies considerably under their maximums, which in most cases are low by present-day standards. Conditions in the northern and central part of the field are such that little consideration has been given to the replacement of such fans by others smaller and more efficient, but this subject is receiving attention in the southern part of the field, where operations have a longer probable life and ventilating conditions are more onerous.

The main fans handle large volumes at low pressure, generally below 3 inch water-gage or static pressure at the fan inlet. Variations in performance ordinarily are measured by water-gage observations and summations of underground air measurements based on anemometer readings made in the center of airways only and uncorrected and therefore much higher than actual quantities. More accurate measurements are obtained only at long intervals, usually when some major change is contemplated. The mine law requires a recording pressure gage at all fans, but many fans in the southern part of the field are also equipped with a stationary indicating U-tube pressure gage for checking the recorder.

In the northern and central parts of the field, the equivalent orifices of the fan circulations generally range from 20 to 50 square feet, whereas in the southern part the general range is between 40 and 70 square feet. The maximum noted was 112 square feet - 415,000 c.f.m. at 2.2 inches pressure. The corresponding ranges of resistance factors - pressure required for a flow of 100,000 c.f.m. - are 4.0 to 0.64 and 1.0 to 0.33, respectively, for the two areas, and that corresponding to the above-mentioned maximum is but 0.13.

In general, average quantities handled per fan are considerably larger in the southern part of the field than elsewhere, and the pressures also average somewhat higher. Maximum pressures are about 3.5 inches water and maximum quantities about 400,000 c.f.m.

Generated on 2024-09-18 03:13 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY



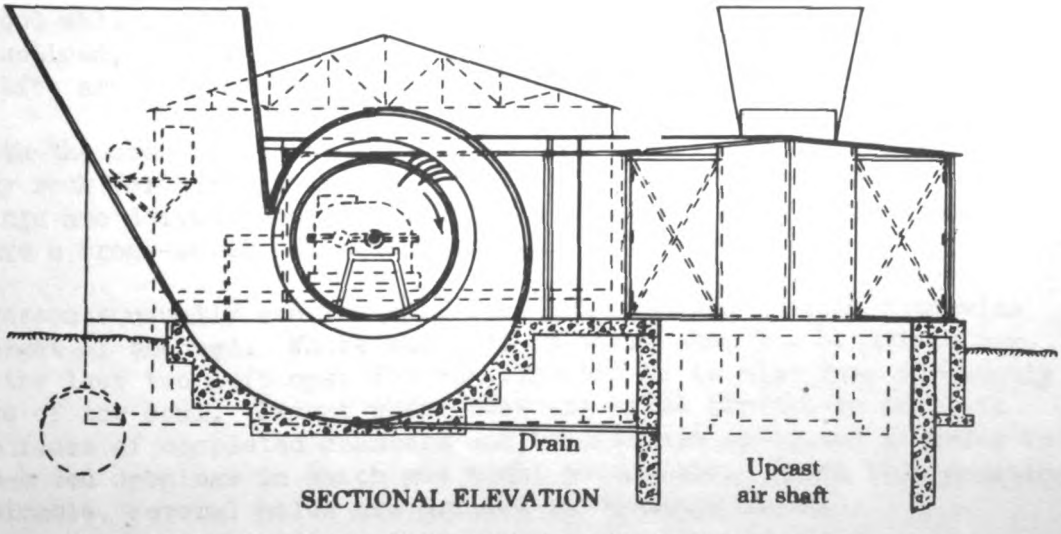


Figure 15.- Outlying fan installation with automatic standby operation.

Generated on 2024-09-18 03:10 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Average quantities circulated per man employed underground range from the legal minimum of 200 to about 400 c.f.m. in the northern and central areas and 400 to 600 c.f.m. in the southern areas. Corresponding figures for these two divisions of the field, in terms of tons of air circulated daily per ton of average daily production, are about 3.0 to 7.5 for the former and 6 to 11.5 for the latter. Since the fans are operated continuously during periods when the collieries are idle, and at many totally inactive collieries, the actual total tons of air handled are probably double these figures on the average.

Use of Fan-Tubing Auxiliary Units

Fan-tubing units are used only to a very limited extent at a few nongassy collieries for ventilating dead ends, particularly rock tunnels, slope extensions, and development openings for special conditions with mechanical mining systems, such as scraper operations in low coal mined through short 'rock holes' from gangways on an adjacent bed. An assortment of units is used, but all are forward-curved-blade, direct-driven, centrifugal fans. Most of the tubing is 12-inch canvas, although some 16-inch canvas and some spiral-riveted iron pipe has been used for long rock tunnels. There were probably not more than 50 units in the whole field in 1934.

Conditions and Dimensions of Airways

Main airways average 7 feet high by 12 feet wide throughout the field, including the downcast compartments of shafts. The latter are lined with timber sets, usually on 5-foot centers. Few of the slopes, planes, rock tunnels, or lateral gangways require timber, except in caved ground, where somewhat smaller openings are used in conjunction with mechanical systems of mining. The upcast compartments of the shafts range from 10 feet by 12 feet to 12 feet by 14 feet in the northern and central parts to 12 by 14 to 14 by 18 in the southern part; they are generally unlined, except through the surface soil, and are separated from the downcast compartments by concrete, brick, tile, or wood walls. Separate airshafts have the same size range and are generally unlined, except through the surface soil. A number of the more recent airshafts are concrete-lined, circular, and 16 to 21 feet in diameter.

With the use of mechanical systems of mining it is not necessary to take up any rock for airways and for parts of some gangways in thin beds. Such openings are driven somewhat wider than those of normal height and usually have a cross-sectional area greater than 50 square feet.

Crosscuts usually are 10 to 12 feet and headings 8 to 10 feet wide and the height of the bed. Where the roof is poor, they may be driven narrower and the last two left open for ventilation, as is also done frequently in the case of low coal. Except where they are holed through to the lift above, the faces of completed chambers and breasts are connected in order to avoid dead-ended openings in which gas might accumulate. Where this practice is impracticable, several holes are drilled to openings above.

Generated on 2024-09-18 03:10 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The flow of air currents through the small openings in back of line brattices at development faces is relatively restricted, since the openings range from 10 to 20 square feet only in cross-sectional area. One or more of the stoppings in the vicinity of development faces are therefore not made tight, so that the leakage through them will augment the quantity going to the chamber faces, where larger quantities are required.

Rock planes or "rock holes", generally about 7 by 12 feet, frequently are used to connect airways across faults, rolls, and overlaps, and to pass air currents from one bed to another in order to pass locally caved or unworked areas or to shorten the length of travel of return air currents.

Ventilation Practices

Experience has shown that a relatively large flow of air sweeping active faces is required for good ventilation, even in so-called nongassy beds, and that to secure such a flow - from 5,000 to 15,000 cubic feet per minute - an elaborate system of control features, such as stoppings, doors, air bridges, regulators, and deflector brattices, is required, and that the major control features must be of substantial construction and reasonably air-tight. On the other hand, a small flow of air is required through all openings to prevent local gas accumulations, and controlled leakage is therefore an important part of each distribution system, accomplished largely by accommodating the details of construction of control features to the duty required of them. In gassy beds, even wall stoppings, erected primarily for air-tightness, must be provided with a small opening at the top to prevent the accumulation of gas against the top of the stopping and to allow a small amount of air to "screen" through walled-off openings.

Stoppings

"Wall" stoppings, that is, stoppings designed to be as nearly air-tight as possible, are generally dry-wall gob stoppings faced with plaster throughout the older operations and concrete in the newer operations. Opinions differ as to which is the cheaper but the former are undoubtedly less of a handicap to later pillar-mining operations while the latter make a much more effective stopping. The gob stoppings are 3 feet to 8 feet wide and of double masonry dry walls filled in with fines. The thinner walls are now preferred as being sufficiently effective and more easily handled in pillar-mining operations than thicker walls. Stoppings on important airways sometimes have one or both walls laid up in lime-sand-cement mortar, but the large majority are merely plastered with the mortar on the intake side. Where sufficient gob is not available, and throughout the operations of certain companies, wall stoppings are built of plain concrete. As preparation, these require only the cleaning of the surfaces affected, and no hitches are made in ribs or floor. Forms of inch boards are nailed to two rows of small-diameter posts to provide for an 8 to 10 inch wall. Materials are mixed in a small box at each job. A 1-2-3 or 1-2-5 mix is used depending on the permanence of the stopping. In some places, cinder aggregate is used in place of mine rock aggregate. No woodwork is incorporated in concrete stoppings,

Generated on 2024-09-18 03:11 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

as experience has shown that it rots and causes both weakness and air leakage.

Wall stoppings are placed in far enough from pillar corners so that sloughing or chipping off of the pillar will not affect the wall. Settling of the wall usually provides sufficient drainage opening at the top of the stopping to prevent gas from accumulating in the small dead end below the stopping.

Where tightness is not necessary, as in chamber crosscuts and breast headings, unplastered-wall stoppings usually are erected where plenty of suitable gob rock is handy. Otherwise, a 'brattice' stopping of 1- by 12-inch rough hemlock boards nailed to small-diameter posts or wood rails (3- by 5-inch) is generally used. Holes along the roof and ribs are patched with short pieces shaped with a hatchet. Bratticemen become very proficient and make such stoppings reasonably tight with few tools and with little effort or waste of time.

When it is desired to reduce leakage to a minimum at an erected brattice stopping, brattice cloth is usually used to cover the small openings, the cracks between boards are cleated, and sometimes feather-edged boards are driven against the roof and ribs and then nailed in place. However, none of these methods are very effective and no attempt is made to use brattice stoppings in places that require wall stoppings.

Canvas brattices are used occasionally for crosscut brattices in places in nongassy operations.

Line Brattices

Wooden line brattices are used wherever practicable for deflecting air currents so that they sweep active working faces, both in development and chamber openings. They are constructed of random lengths (up to 16 feet) and widths (up to 12 inches) of 1-inch rough hemlock boards nailed to small-diameter posts or wood rails (3 by 5 inches) and to each other. They are overlapped, so that no sawing to length is required, and are put on from the most convenient side, usually the wide side, of the working place. In heavily timbered openings, wooden-box conduits sometimes take the place of line brattices.

In low beds, where cars are used in chambers, the track is carried along one side of the chamber and the gob is piled tight to the roof so as to leave a narrow opening along the opposite rib. This opening is termed a "cundy", said to be a contraction of conduit. Canvas checks across the road and the "cundy" just below the last open crosscut force the air to sweep the face. In places, the check across the road is required only until the face is cleared after blasting.

Brattice cloth of nonflammable, closely-woven burlap, usually termed "canvas", is used for temporary extensions of line brattices, up to 20 feet long,

Generated on 2024-09-18 03:14 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

for sections of line brattice in scraper-loading places, where the scraper has to pass through the brattice, and for line brattice in places where multiple shot-firing is practiced. Canvas line brattices usually are hung on nails on top and bottom boards supported on posts or props. Canvas extensions are more generally hung on nails set in pegs driven into holes in the roof. Canvas brattice is usually taken down for each blast at an adjacent face.

In long rock tunnels, concrete line brattices 4 to 8 inches thick and built similar to wall stoppings have proved effective, although they must be protected from the effects of blasting concussions by pressure-release panels set in the wall at intervals of 20 to 30 feet. These are small openings, usually 1 by 3 feet, covered with a piece of brattice cloth slightly larger than the opening. The canvas is nailed to the top of the opening and is weighted with a 2 by 2 inch cross-cleat at the bottom. The cloths are displaced by the blasting concussions, thus equalizing the pressure on both sides of the wall, but immediately fall back into place or, if displaced, can be replaced easily. The concrete brattice is carried to within about 60 feet of the face, and extensions toward the face are made with brattice cloth between blasting periods. In short rock tunnels, single 2-inch plank brattices, or double plank brattices have proved sufficiently effective.

Line brattices usually are carried up to within 30 feet of the face under ordinary conditions of gas occurrence or for smoke removal only. In some places the gas conditions require that line brattices be kept as close as 10 feet to the face. Practically all line brattices are erected as "blow" brattices, that is, to carry air to the face through the narrow opening formed by the brattice, even though a brattice door or check canvas across the track is required for certain places, as at the face of the airway in figure 7A and the face of the gangway in 7B. Where the door or curtain, however, would add an element of danger, "exhaust" brattices are used to eliminate this feature, as shown in the last chamber inby of figure 7A and the corresponding breast of figure 7B.

Deflector Brattices

Brattice stoppings are used in various ways for deflecting air currents to sweep local high spots and particular areas of gas accumulations. These sometimes take the form of doors across the lower part of the cross-section of gangways, or "bar-room doors", or of stoppings of similar construction across passages not used for haulage. In some places, where gas enters along one rib, a narrow brattice is erected from floor to roof against the opposite rib to deflect a higher-velocity current past the point of gas entry. Similar horizontal brattice deflectors are erected often across openings to keep the high areas above timbered sections clear of gas, or such sections are filled in to give a more regular roof profile. Where gas tends to collect in a cavity in the roof, the usual remedy is to run a small-diameter pipe from the cavity to a nearby return airway.

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-18 03:12 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

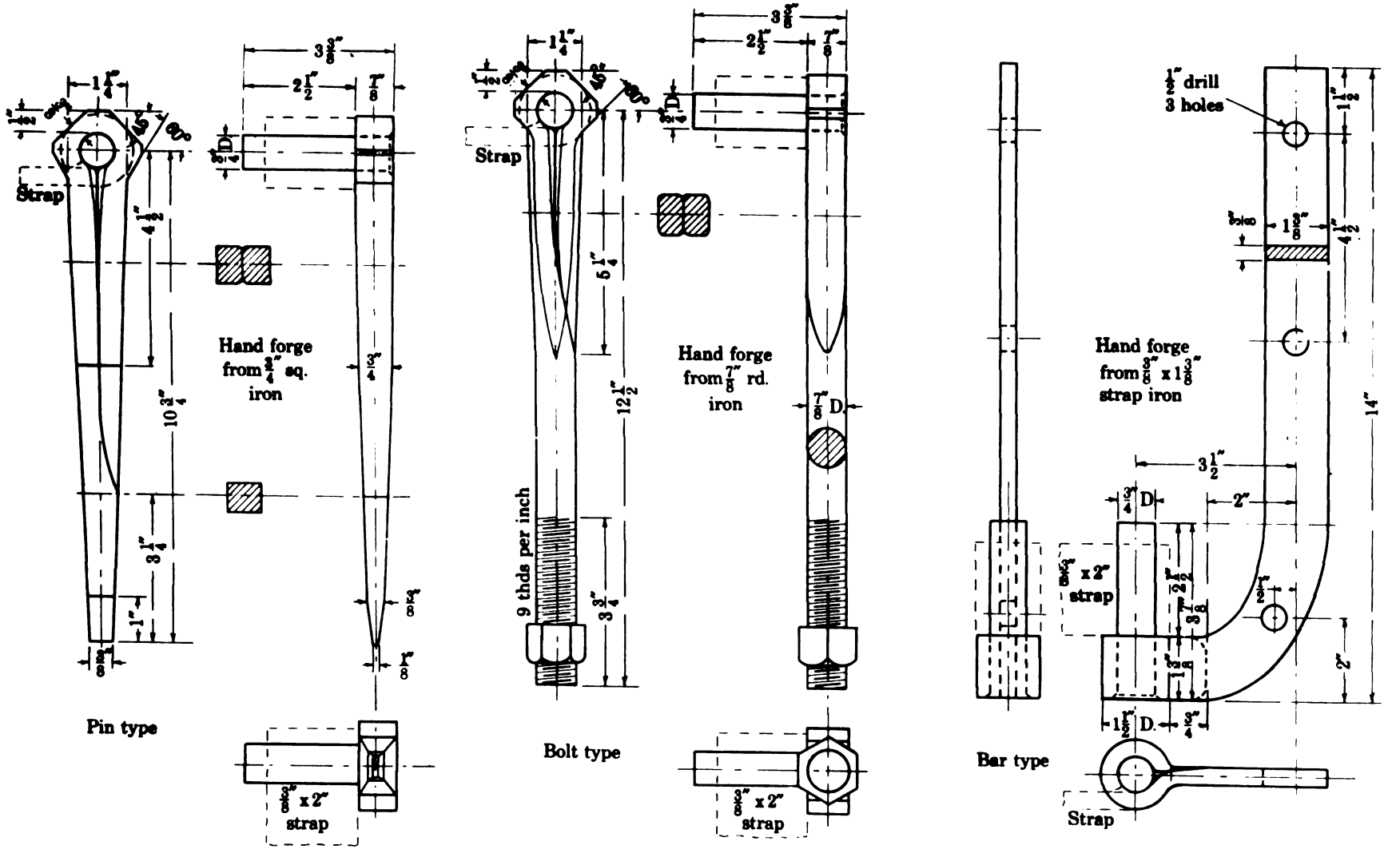


Figure 16.- Representative designs of "door hooks" or studs of strap-type hinges used on ventilation doors.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Doors

Main doors are erected in groups of three, two to serve as an airlock and a third as a spare immediately available to take the place of a damaged door. In relatively flat workings many automatically operated doors are used, rail-operated doors being standard and giving good service regardless of grade and other operating conditions. Some of the required air-locks are in slant cut-off crosscuts or "sections" between gangways and airways, where the space available is not sufficient for the installation of an air-lock of rail-operated doors. Where this condition exists, the second main door and the reserve door are placed in the gangway. Recent installations of electric motor-operated doors have met this situation effectively. These doors include a safety feature that provides for release of the operating mechanism if the door is bumped by a motor or car. Three colored lights indicate at all times whether the door is shut, opening, or open, and a separate hand-operated small door is included in the same frame to provide for passage of men. A red-glass insert at motor headlight height gives adequate warning to men on the opposite side of the door of the approach of a trip. Practically all main doors in operations on pitching beds, and the large majority in flat bed workings also, are hand operated. In most collieries, all main-door airlocks have an attendant or door-boy, whereas in some the main airlocks are supplemented with additional or 'check' doors, and extra brakemen on the motor crews open and close all doors for transportation.

Automatic doors usually are set in a concrete frame. Other main doors are set in concrete frames or in masonry frames of gob rock laid up in lime-sand-cement mortar, with the sides shaped roughly as semicircles about 3 feet in diameter. The cap piece is usually made of two wooden rails spiked together, with the lower one cut out to provide a slot for the trolley wire where required.

Doors are made of two plies of 1- by 12-inch hemlock nailed together. One ply is set vertical and the other horizontal. They are hung on a batter, provided partly by the frame and partly by offsetting the lower hinge, and are self-closing. The door is hung from posts, set in the frame, by strap hinges, 1/2 to 3/8 by 2 inches and 5 feet or more in length. Common hinge stud designs are shown in figure 16. The doors average 6 by 9 feet, are somewhat irregularly shaped, as required by conditions, and are built in place. Air tightness is secured by 1 by 6 inch cleats nailed inside the frame at right angles to the door. These are adjusted from time to time so that the door closes flush against their edges. Wooden sill blocks, which also act as stop blocks, extend between rails and from rails to frame. Extra tightness is obtained, where required, by nailing brattice cloth to the edges of the door, particularly along the bottom.

As a rule, doors have no counterweights or latches, but counterweights are sometimes placed on doors on inclined manway openings to facilitate opening them, and occasionally double doors are installed for the same reason.

Small trap doors are placed in wall stoppings at infrequent intervals to provide access to return airways and inactive workings, although an attempt is made to keep their number to a minimum. They are substantially constructed

Generated on 2024-09-18 03:10 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

and average 2 by 3 feet. Various types are used - slide, vertically hinged, and horizontally hinged. Usually they are set so that they cannot be unintentionally left open, and in some thick gob stoppings are placed in pairs, at each end of a small conduit extending through the stopping, forming an airlock.

Brattice Doors

Brattice doors are used where tightness is not required nor desirable. These consist of a single ply of horizontal 1-inch boards held together by a "Z" brace, composed of horizontal boards, across the top and bottom joined by a diagonal bottoming on the hinge side, set in a similarly constructed post-and-board frame across the opening. They are used largely in line brattices and check brattices and to close off chamber entrances.

Canvas curtains are used instead of brattice doors only until the door can be conveniently placed, or in openings where a wooden door would not be practicable.

Air Crossings

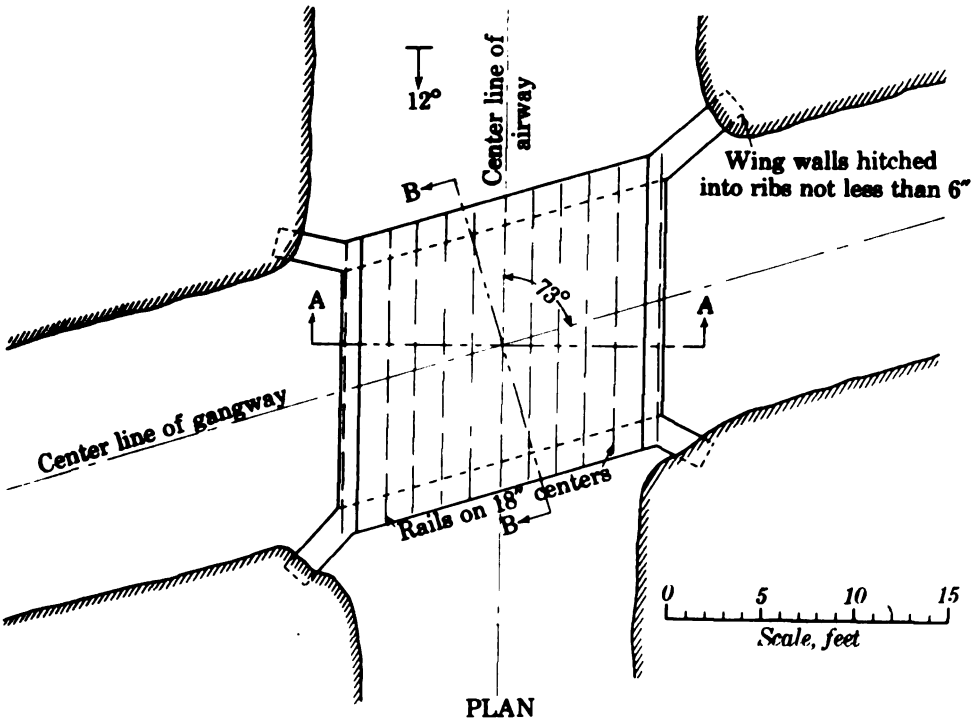
Although natural air crossings are provided where feasible, and rock holes may often be driven to obviate the necessity for a crossing, a large number of air-crossing installations must be made notwithstanding efforts to keep their number to a minimum on account of the expense involved. Practically all are overcasts or "air bridges" of very substantial construction. Many designs are in service, including some very old installations of heavy masonry construction with arched tops. The usual design is concrete reinforced with scrap steel rails, as shown in figure 17. A design of concrete and H-beam construction is now being placed in service as standard construction for permanent locations by one of the large companies. A sectional, steel, liner-plate design used by another large company for temporary locations is shown in figure 18. Where a greater degree of permanence is desired, the plates are supported on longitudinal concrete copings. In addition to lower cost, this design has the considerable advantage of almost complete salvage. Free areas for both air currents at an air bridge are made sufficiently large for all present and probable future conditions, but are usually about the same or slightly larger than the adjacent airways. While it is general practice in flat workings to bank up the side walls for smooth flow conditions with the material shot down in enlarging, in pitch workings the material is usually loaded out unless required for banking to provide a travelingway or to improve flow conditions at overcasts on "open" splits only.

Under special conditions of minor returns crossing large openings, concrete ducts erected on piers are sometimes used as overcasts. A few undercasts are in use, but only where special conditions demand this type of construction.

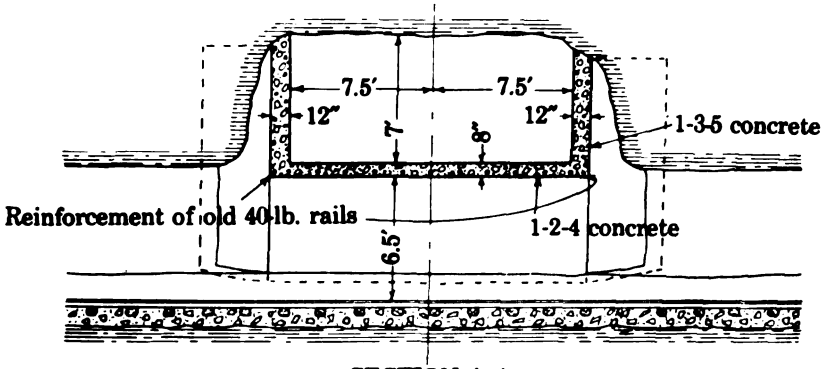
Regulators

Regulators are erected, when required, near the return end of the split. Although many of the main regulators are iron slides in concrete stoppings, the more general construction is a wooden slide door in a wooden brattice. Minor

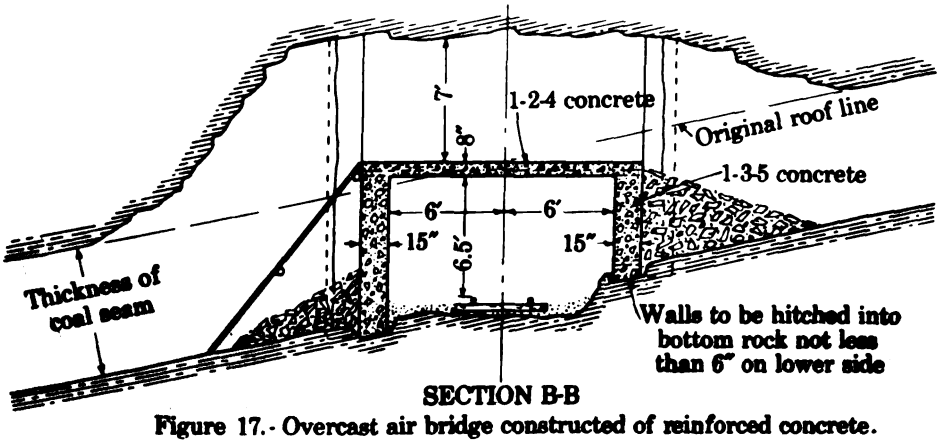
Generated on 2024-09-18 03:11 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY



PLAN



SECTION A-A



SECTION B-B

Figure 17.- Overcast air bridge constructed of reinforced concrete.

Generated on 2024-09-18 03:24 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

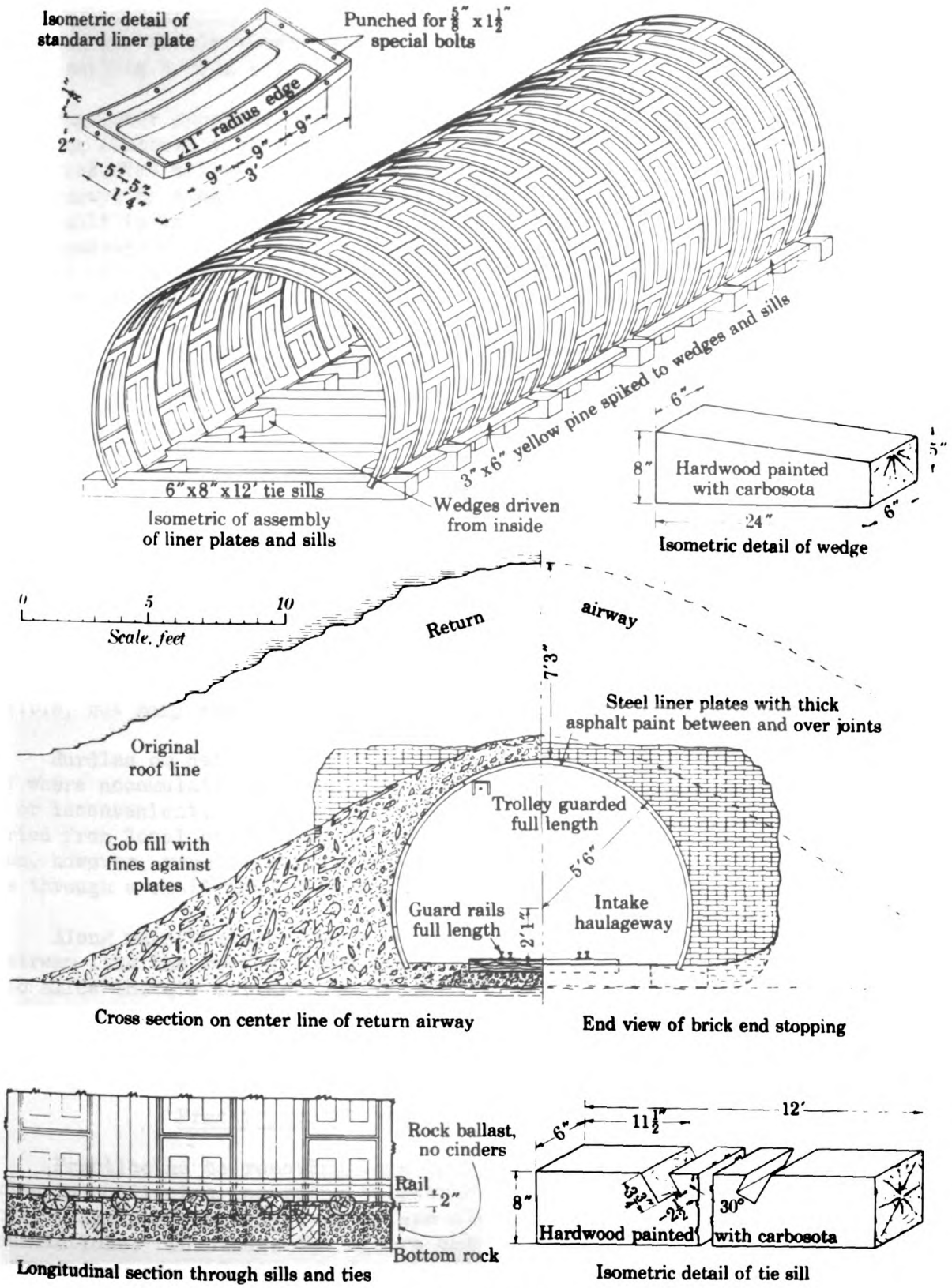


Figure 18.-Overcast air bridge of steel liner plate construction.

Generated on 2024-09-18 03:10 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

regulators are merely wooden brattices with a central opening, adjusted for size by nailing boards on, or removing them, as required.

Regulator openings are used in many places for passage of officials in inspecting inactive workings and measuring air currents. Slide regulators are easily disturbed unless locked whereas the hole-in-brattice type is rarely disturbed except by blasting concussions. Where the required degree of regulation would result in an opening in the fixed-opening type that would be too small for man passage two are sometimes used in series in airlock fashion so that the sizes of the openings may be made larger for the same required degree of regulation or pressure loss.

Practice in Preventing Gas Accumulations

Precautions are taken to prevent the accumulation of gas in either active or inactive workings. The exact procedure followed for any particular set of conditions is a matter largely determined by the mine foremen in charge of the section. The main requirement, of course, is that all parts shall be swept by the air currents and that all dead ends to the rise, however small, have at least a drain opening to some higher opening which is ventilated. Detailed coursing of the return air currents along the top of first-mined sections and along the crests of anticlines and rolls accomplishes the major part of this requirement.

Wall stoppings on openings on the dip of the measures are not only erected as close to intake airways as the stuffing of the pillar corners makes feasible, but many are also provided with a drain opening along their top.

Hurdles or deflector brattices are generally used for high spots in the roof where accumulations have been detected. Where hurdles would be ineffective or inconvenient, 2- to 4-inch-diameter pipes or larger wooden conduits are carried from local high spots on intake airways to an adjacent return airway. These, however, require regular inspection, as they can be rendered inoperative through a small "fall" disturbing the pipe or conduit.

Along main haulage routes where such "pot holes" exist, an effort is made to stream-line the roof or "iron out" the hole by trimming down on each end of it to allow the air currents to sweep against the top; or, in some cases it is more practical to build in a concrete slab roof at the normal roof height and fill the void above with a suitable packing material, such as clay or fine culm.

Practice in Dispersing Gas Accumulations

Practice as to removing local gas accumulations when they are found varies in collieries according to established custom. In some only mine officials, assisted by bratticemen, are allowed to attempt to disperse such accumulations. In others the miners erect their own brattices and are allowed to remove gas accumulations under the direction of a mine official.

Generated on 2024-09-18 03:13 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Gas accumulations usually are dispersed readily in flat workings by repairing or replacing the appliance responsible for the accumulation, by augmenting the air flow to the affected area temporarily, or by deflecting air currents to the affected area by brattices. Where breasts on steep pitches fill with gas, due to some derangement or blocking of the distribution system or to a local outburst of gas, considerable difficulty is experienced in removing the gas or, rather, in getting the body of gas into movement. Once started, it usually moves out as readily as in flat workings. The tendency to immobility is due to the natural pressure difference generated by the difference in weights of the two air columns involved - one gas-free and the other gas-charged. The pressure thus generated is opposed to the fan-produced pressure and is difficult to overcome at times. It is necessary to keep the gas content of the downcast column low enough to prevent the natural draft pressure generated from overcoming the fan pressure available, and removal is a slow process of successive small "bites". Sometimes very small artificially-produced pressures, such as those caused by coal or a box falling down a steep manway opening, suffice to overcome a condition of pressure balance, and the gas starts moving out.

On account of the relative lightness of the gas-air mixture, its travel through pitch workings may produce unexpected conditions of flow, to which long experience as to what has happened is about the only practical guide.

Natural Draft Effects

Natural drafts are minimized as much as possible on account of their effect on the constancy of ventilation conditions, since any lack of constancy in distribution conditions not only adds to the expense of maintaining proper control over distribution but also introduces an element of danger in gassy operations.

Although differences of surface elevations up to 400 feet are possible at the collieries that flank the hills, it is the policy of most companies to avoid openings on the hillsides as much as possible, except in naturally ventilated sections, and to concentrate surface openings at about the level of the openings of the operating shafts.

Many surface openings exist on the hillsides as a heritage of past operations and as a result of more recent pillar-mining in shallow seams. The major effects of natural drafts are confined largely to the upper parts of such seams where ventilation requirements are a minimum and natural drafts alone suffice for ventilation. Large areas that would also be adequately ventilated by natural drafts are often segregated from these upper sections and ventilated mechanically.

Although natural draft effects due to differences of surface elevations of openings are being eliminated to a great extent, the seasonal effects, due to seasonal temperature differences in downcast air columns and such small surface columns as exist, still cause large seasonal variations, and seasonal adjustment of control features is required.

Generated on 2024-09-18 03:15 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Natural draft pressures generated locally in steep pitch workings not only make it difficult to disperse local gas accumulations but also demand a sufficient intensity of fan pressure to overcome the adverse natural draft pressure usually present. While it is possible to reduce the normal volume of flow in flat workings materially during idle periods, as a matter of economy, the same procedure is not always feasible in pitch workings, since the accompanying reduction in fan-developed pressure may bring about a balanced condition of pressures which acts to reduce the flow through sections where the returns are locally downcast, with resulting gas accumulations.

Air Conditions

With few exceptions, the air conditions are cool and comfortable everywhere underground throughout the year. Occasionally, work on active fire areas is performed under uncomfortably warm air conditions, and places close to the major intakes are uncomfortably cold in winter, although generous provision is made for heated rooms for routine activities.

Temperatures in working places range from about 50° to 65° F., with wet-bulb depressions commonly ranging from 2°to 5°, corresponding to a relative humidity range of about 75 to 90 percent.

While a few scattered sections are wet, most working places are damp to dry, and the steeper pitch workings are normally very dry. In the latter, the coal falls long distances to the gangways, and dust control requires copious ventilating currents, greatly exceeding those required for gas dilution or rapid dispersion of blasting smoke.

Use of Air Analyses

Samples of the general mine air, taken at various times in the past in the collieries of the larger companies, have always shown air of good quality in working places, with oxygen above 20.5 percent, carbon dioxide under 0.3 percent, and no carbon monoxide.

Methane gas conditions are gaged by the proper mine officials on their regular inspection trips, by flame safety lamp tests; that is, it is known for every accessible place underground that the gas content is or is not below about 1 percent. Standard procedure is to use a reduced flame on the safety lamp when testing for methane. Most fire bosses, however, use the normal flame for detecting the presence of methane and the reduced flame for quantitative determinations only.

Air analyses are used most in connection with mine fire-fighting operations. Hundreds of analyses have been required in certain instances for maintaining the close check on air conditions in sealed areas required for this work.

Major and minor returns at most collieries are sampled at intervals of two or more years, but at those of the more progressive companies present

Generated on 2024-09-18 03:14 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

procedure is to make occasional or frequent checks of all gaseous sections with a methane detector. The uniformity of results, as respects major returns, over a period of months or years is remarkable, as is also their correlation with easily observed general conditions of operation. Recent results of sampling major returns, initiated at the request of Deputy State Mine Inspector Joseph Walsh and carried out by R. D. Currie, associate mining engineer of the United States Bureau of Mines in cooperation with the various State mine inspectors and company officials, have been compiled for coming publication 4/ as a Bureau of Mines Information Circular. They show that very few of the main returns in the northern and central parts of the field had gas contents in excess of 0.1 percent, and that the maximum was about 0.3 percent. These are all nongassy or only slightly gassy operations. In the southern part of the field, which includes many very gassy operations, with at least 15 collieries discharging 1-1/2 to 6-1/2 million cubic feet of methane per 24 hours, few of the main returns had gas contents in excess of 0.5 percent and only two at a rather small operation exceeded 1.0 percent.

Colliery records show that few samples taken close to active sections show more than 0.5 percent, even at the most gassy operations, although more may be picked up by returns traveling through inactive workings, which are all open and ventilated where practicable. This content - 0.5 percent - is generally regarded throughout the field as the maximum permissible for safety in returns from active sections.

Production of methane, in terms of production of coal, varies greatly throughout the field but depends largely on relative location although influenced locally by depth and relative amounts of first-mining and pillar-mining operations. In the northern and central parts the rate rarely exceeds 100 c.f.m. per 24 hours per ton of daily production in old workings, or 300 c.f.m. in newer operations with considerable first-mining in progress. In the southern part, however, 300 c.f.m. per ton is about the minimum, 1,000 c.f.m. a fair average, and the maximum is about 1,600 c.f.m. per ton for large operations.

Personnel

The local colliery mine foremen are, by law, responsible for the general and specific features of the ventilation of their respective sections of the underground workings. In the case of the larger companies, they initiate major changes, but the exact procedure for meeting a particular set of conditions is arrived at in conferences with higher officials and interested staff officials, and approved by the general manager.

4/ Currie, R. D., Air Sampling in the Anthracite Region September 1932 to June 1934. Unpublished manuscript. (Published as: Methane-Indicating Detectors Prove Dependable in Sampling Air in Anthracite Mines: Information Circ. 6874, Bureau of Mines, February 1936)

Generated on 2024-09-18 03:10 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

A ventilation inspector is attached to the safety division of the staffs of several of the larger companies, with the division head reporting direct to the general manager. In addition to making periodic inspections of all working places, he is available at all times for consultation on changes in distribution, or, in emergencies, to take charge, under the mine foreman, of major changes in distribution required by changes in operating conditions.

Local differences in practices, mining conditions, and job designations, even as between the various collieries of the same company, result in large differences in the personnel required for maintenance and operation of control features, particularly as respects the number of bratticemen and doorboys. As far as can be ascertained from the records available, about 1 to 2 percent of the underground force is engaged on ventilation matters in the northern and central parts of the field, whereas in the newer operations of the southern part the proportion is about 3 to 5 percent, increasing to 7 to 10 percent for some of the older very gassy collieries.

Costs

No attempt has been made to present cost data in this paper for a number of reasons. Anthracite operators are traditionally opposed to giving out cost data, and although several companies indicated a willingness to contribute data on this phase of the subject, yet the available records were acknowledged to be so incomplete that the practical impossibility of compiling truly representative data was evident and it seemed more desirable to omit these data than to present inaccurate data. The same condition applies to cost data of a more detailed nature, such as for installations of control features; the data secured more or less unofficially were so at variance that it has been considered better to omit them entirely rather than give misleading data.

The rough estimate of $3,500,000, given in an introductory paragraph as the probable yearly cost of ventilation in this field, was derived from the following roughly estimated averages: 25,000,000 c.f.m. at 2.0 inches pressure, over-all mechanical efficiency 50 percent, power at 1 cent per kw.-hr., and power cost one third of total cost. This corresponds to an average for the field of about 14 cents per ton of coal produced.

Generated on 2024-09-18 03:13 GMT / https://hdl.handle.net/2027/osu.32435030644025
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from
THE OHIO STATE UNIVERSITY